Alfred Holl

Epistemological issues of IS modeling

**“From our studies, my impression is that
the American IS researchers develop hypotheses,
the German IS researchers get surveys done and
the Scandinavians think a lot.“**

C. Avgerou, LSE, ECIS 1996, AIS Panel on European Research Traditions in IS

1 Motivation for epistemological research

Why should we do it in the fields of information systems and software engineering?

SWE: systematic development of high-quality software (functionality, on time, user-friendliness, easy maintenance etc.) as an answer to the SW crisis, but not a sufficient one

Software Crisis:
– Software often does not meet the requirements of the organization experts (users)
– Projects often exceed their budgets

Why?
– Are most computer scientists incompetent?
– Are most project managers incompetent?

Or are there any fundamental problems besides model representations (notations) and phase concepts?

Yes, there are.

If a science is based on observation and model construction, it has to discuss the epistemological value of the models used!

2 Background 1

2.1 Objects of information systems: underlying interpretation of IS

Information is a sociobiological category:
information exchange between and within living organisms
IS: mathematical-formal optimization
of the information exchange between humans
(Rupert Riedl 1994)

IS: systematic information processing (→ requires models!)
in open socio-technical systems in business and administration
which comprise interacting
– human components and
– formal components (computers, databases, card indexes etc.)
(adapted from German Wiss. Komm. der Wirtschaftsinformatik)

Models are the essential knowledge of IS.
(Franz Lehner 1997)

The formal models have to be designed
using methods of empirical sciences
such as observation, induction, abstraction, type construction
as shown in *Part 6: Empiristic approaches*.

As formal models are a sort of scientific knowledge,
we have to deal with theory of knowledge, i.e. epistemology.

2 Background 2

2.2 Objects of epistemology

Acquisition of knowledge (cognitive methods)
Nature/quality of knowledge, relation to reality
Limitations of knowledge (truth, correctness)

Epistemology deals with one of
Immanuel Kant's three essential questions of philosophy:

Question	Kant (1724–1804)	Freud (1856–1939)
What can I know?	epistemology	ego, self
What shall I do?	ethics	super-ego
What may I hope for?	metaphysics	it

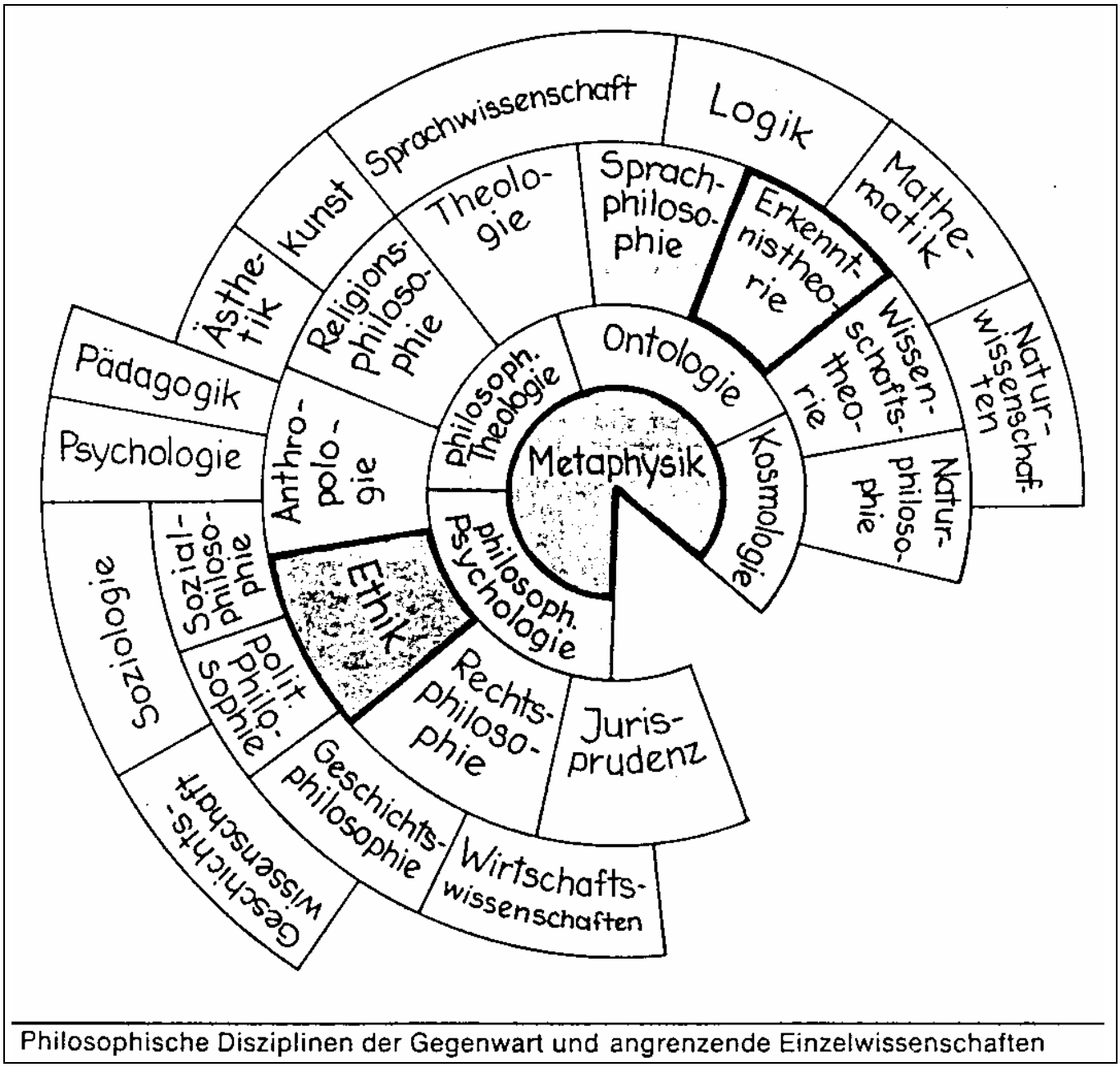
Note the close relation between Kant's trichotomy and
Sigmund Freud's psychoanalytical three-layer model!

2.3 Purposes of science

Description → descriptive models
(often only functional, not structural)
Explanation → descriptive models
Prediction → descriptive models
Organization and design → prescriptive models
(artifacts such as IT systems)

2 Background 3

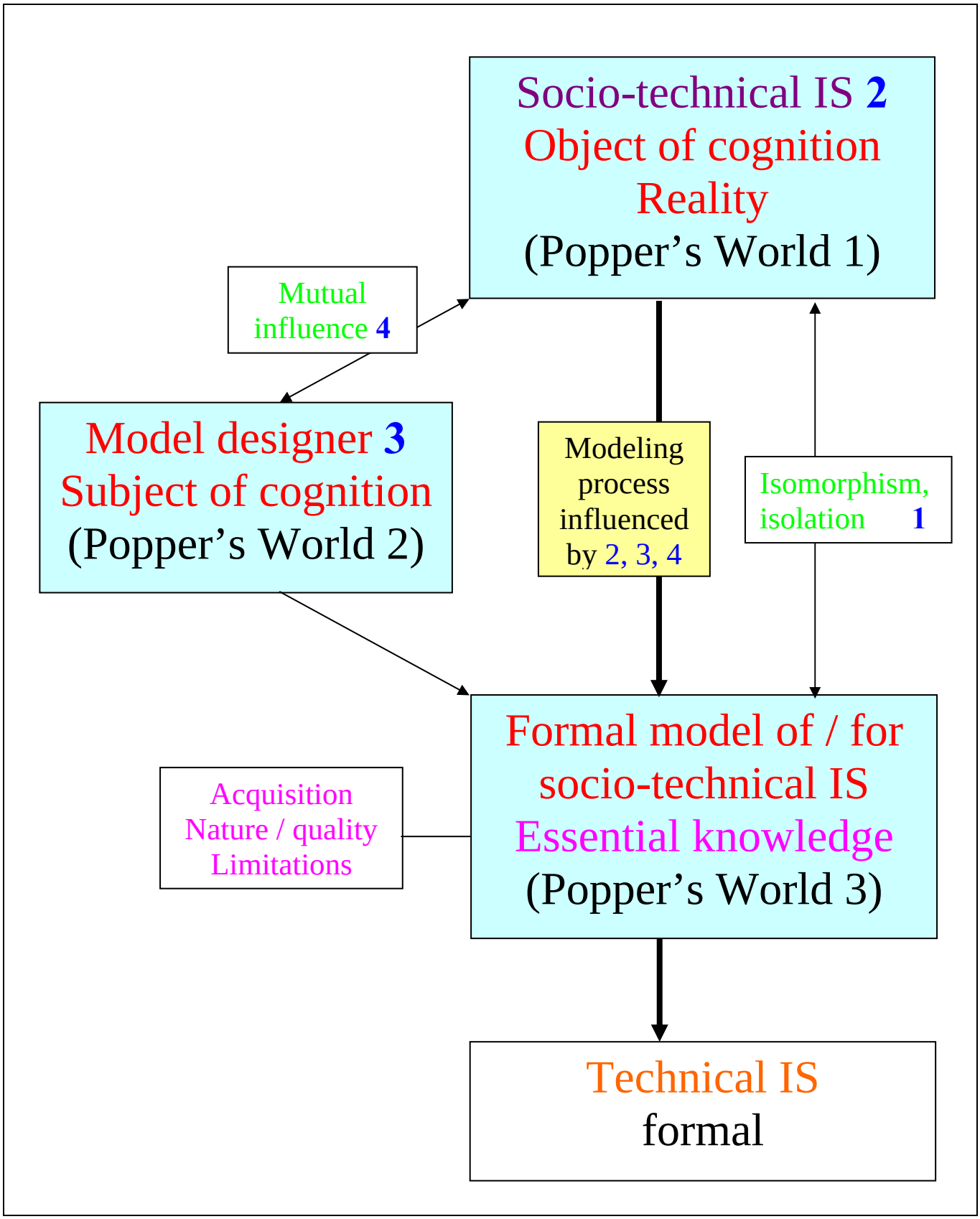
2.4 Related disciplines



Philosophische Disziplinen der Gegenwart und angrenzende Einzelwissenschaften

Philosophical disciplines and their internal and external relations (dtv-Atlas Philosophie, 1991, 12)

3 Examples of fundamental problems 1



Influences on the modeling process and its result, the model

3 Examples of fundamental problems 2

1) The problem of isomorphism (reality – model)
Computers are formal technical systems,
they don't understand anything but formal language and models represented in formal language, i.e. formal models,
but reality is not formal,
can only partly be described in terms of formal language.
Only formal aspects of reality are accessible to computers.

→ Girl and globe

2) Organizations are social systems constituted by humans who are not accessible to formalization.
The formalization of organizations depends on
- **their degree of pre-formalization**
- **their degree of accessibility to / suitability for formalization**
- **time, effort and thus costs necessary for formalization.**

→ Finely and coarsely structured photo

3) The influence of model designers on their models
There aren't any models without model designers (cf. there aren't any paintings without painters).
Models do not appear out of the blue.
Models are the result of cognitive processes where model designers unconsciously use cognitive strategies.

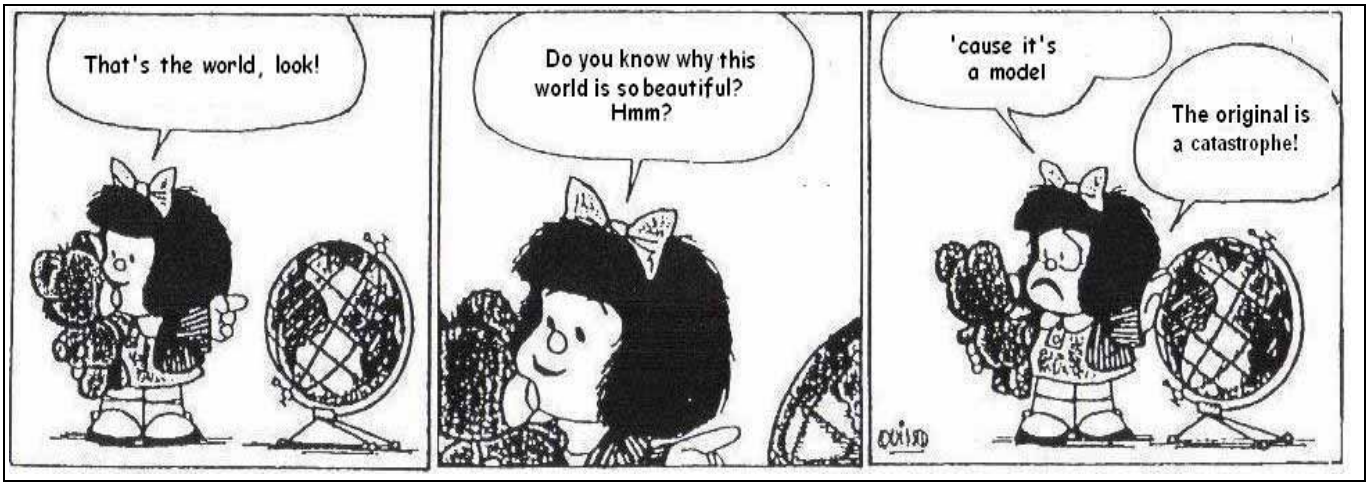
→ Perception psychology

4) The influence of model designers on the organizations observed
Organizations are open, temporally dynamic, complex, social (socio-technical) information(-processing) systems which change their behavior under observation.

→ Ethologist and mole

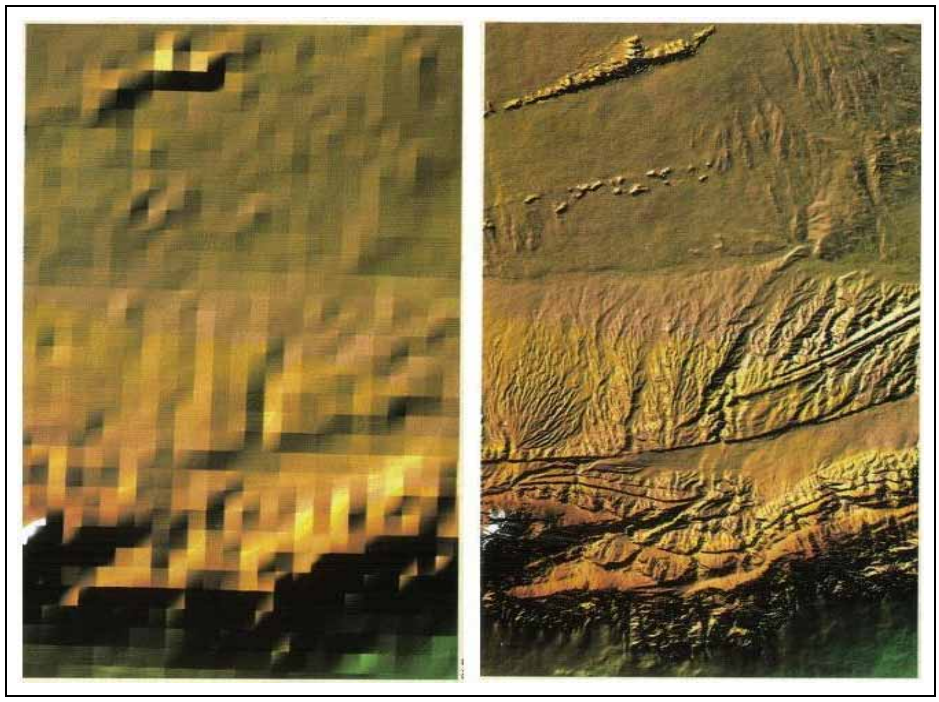
3 Examples of fundamental problems 3

1) The problem of isomorphism



Girl and globe
(Quibeldey-Cirkel, Objekt-Paradigma, 1994, 15)

2) The formalization of organizations



Coarsely and finely structured photo
(Öttl, Das neue Radar, Spektrum der Wissenschaft 2000, 2, 93)

3 Examples of fundamental problems 4

3) The influence of model designers on their models

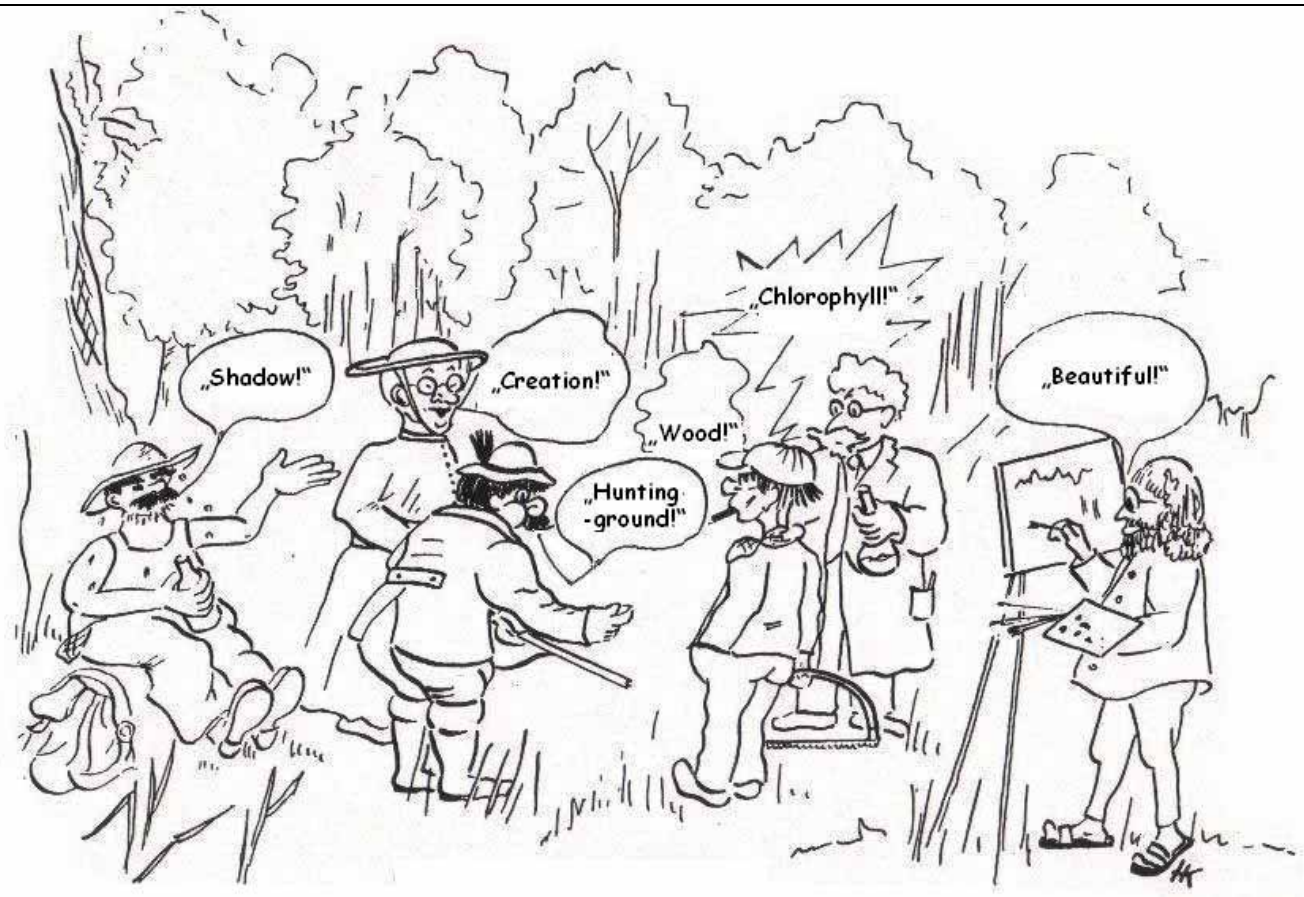


Abb. 4. „Wer sieht den Wald?"

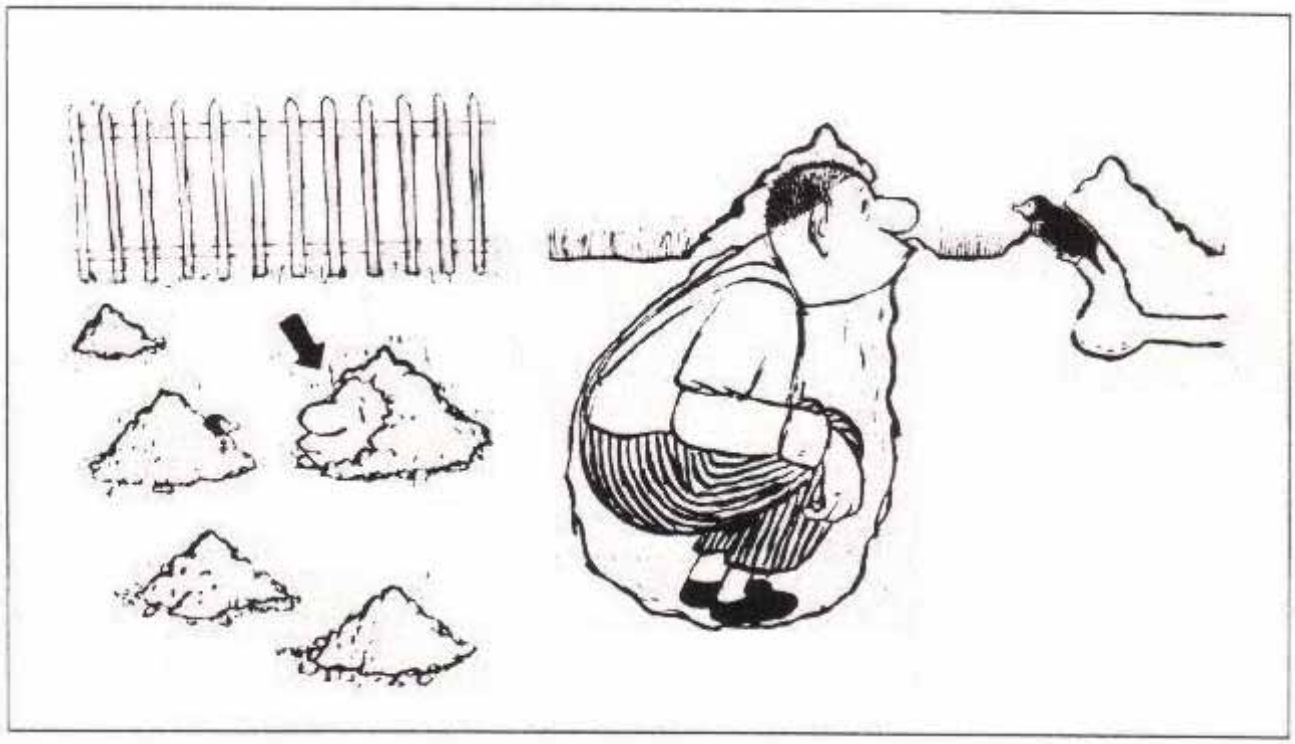
Jedem ist das gleiche „Wahrzunehmende" geboten, jeder „sieht" etwas anderes. Verschiedene psychische Instanzen wie Interesse, Bedürfnisse, Motivation, Einstellungen usw. lassen in der Wahrnehmung bestimmte Merkmale dominieren, andere wiederum werden weniger „beachtet". Wahrnehmung ist nur zum Teil Aufnahme von Informationen, zum anderen Teil ist sie eher eine Selektion von Informationen und auch eine Ergänzung von Informationen.

(Zeichnung von H. Krawielitzki-H.)

"Who sees the forest?"
(Hajos, Wahrnehmungspsychologie, 1991, 18)

3 Examples of fundamental problems 5

4) The influence of model designers on the organizations observed

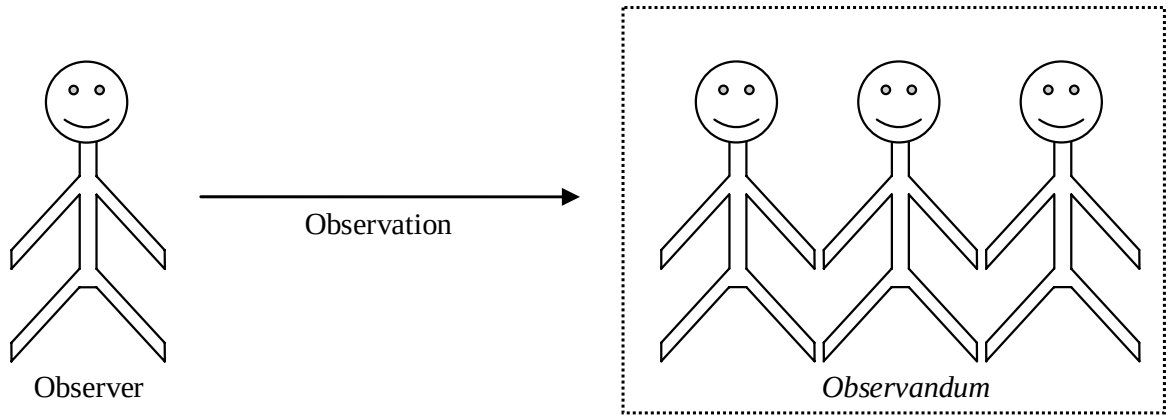


Bei der Systemanalyse komplexer sozialer Systeme wird häufig nicht bedacht, daß die Beobachtung eine Störung und Verfälschung des ursprünglichen Verhaltens bedeutet.

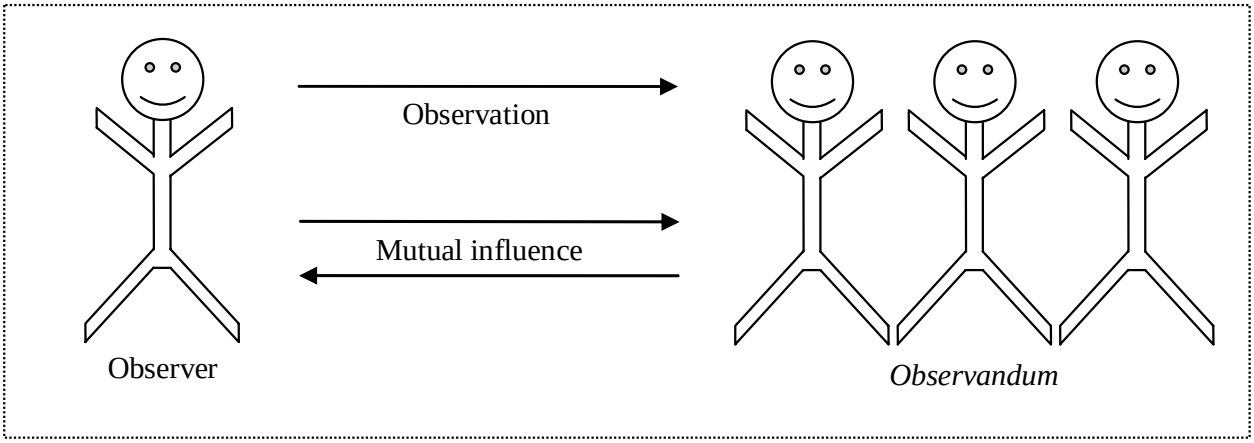
Ethologist and mole
(Loriots großer Ratgeber, 1968, 219 quoted from Schmidt, Simulation in Passau, 1993, 2, 12)

3 Examples of fundamental problems 6

4) The mutual influence observer – observandum



1. Naïve-realistic view: separation of observer and *observandum*

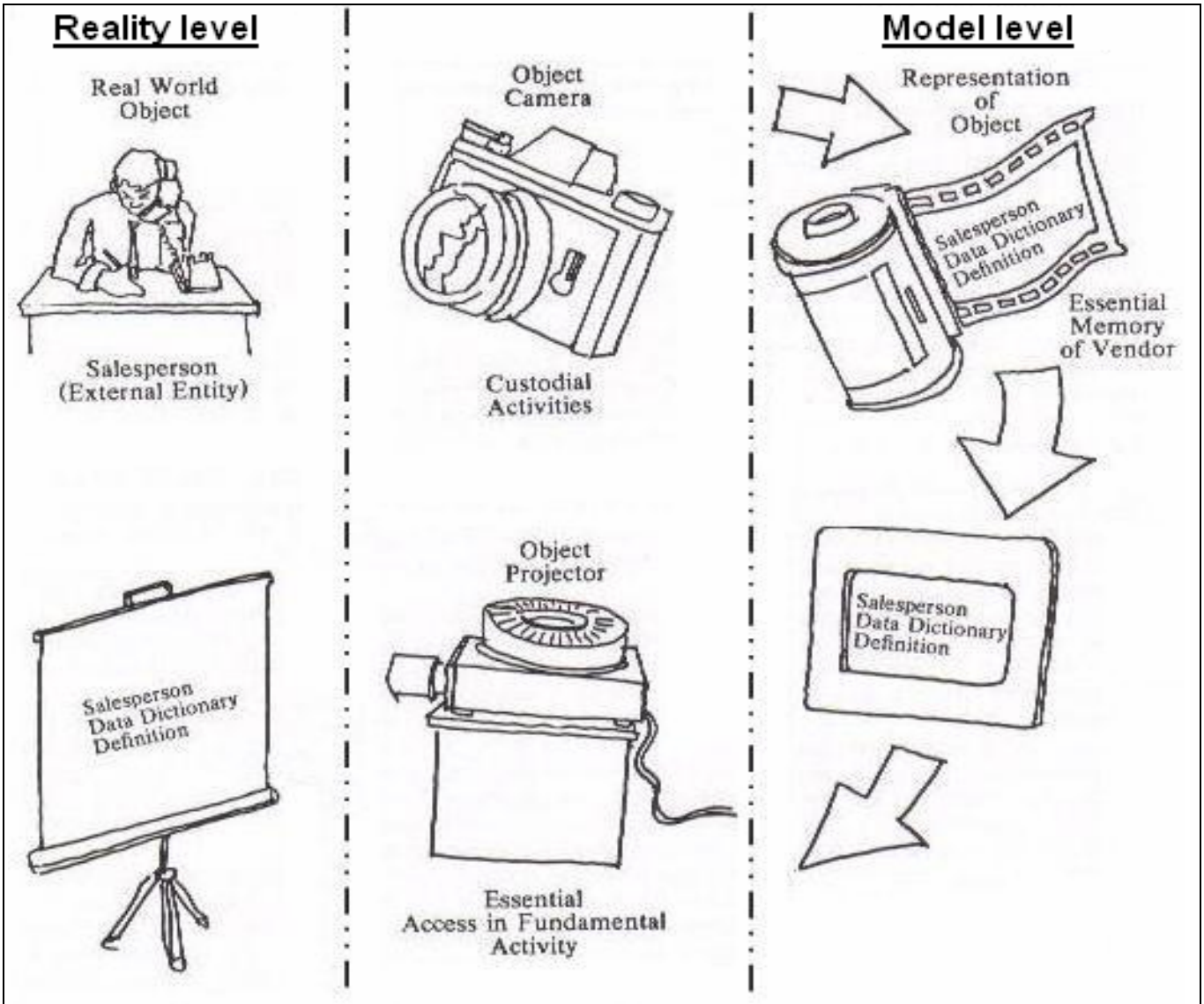


2. Critical-realistic view: mutual influence of observer and *observandum* described as a new system consisting of observer and *observandum*

(Holl / Paetzold / Breun, Cooperative cyclic-iterative knowledge gain in IS anti-aging, 2010, fig. 3)

3 Examples of fundamental problems 7

Summary



Die Datenelemente, die wir im essentiellen Speicher festhalten wollen, sind Darstellungen von sowohl natürlichen wie auch künstlichen Objekten. Mit den Worten von DeMarco: Der essentielle Speicher ist eine Simulation von Dingen, die in Wirklichkeit außerhalb der Systemgrenzen liegen [11]. Der essentielle Speicher ist der Film in einer imaginären Kamera, die wir auf diese Objekte richten, um ihre Eigenschaften als Informationen festzuhalten statt mit Silberbromidkristallen oder mit elektronischen Impulsen. Zu einem späteren Zeitpunkt werden die Daten des essentiellen Speichers dann durch einen Zugriff in die grundlegenden Aktivitäten projiziert. In Abbildung 7.6 wird dieser Vorgang des Abspeicherns und Wiederfindens von Objekten durch den Vergleich mit dem Abbilden und Projizieren von Photos dargestellt.

The modeling process without epistemological foundation (McMenamin / Palmer, Essential Systems Analysis, 1984, 54)

4 Widespread false opinions

A recent research project (Holl / Krach 2002) shows that most literature in the field of SWE ignores those facts!

- **reduction of software engineering to software technology**
- **reduction of modeling to the use of notations (e.g. UML)**

Instead, you can find naive attitudes and wrong expectations towards models everywhere, such as:

1) Models are one-to-one images of segments of reality and every kind of information can be described in formal models.

2) Every segment of reality (each department of an organization) can be modeled completely and with the same precision and the same effort.

3) Models are objective descriptions of segments of reality and appear after some creative process which cannot be described.
Therefore, only notations / symbols are introduced, not methods, and the first (analytical) phase in a phase concept is ignored.

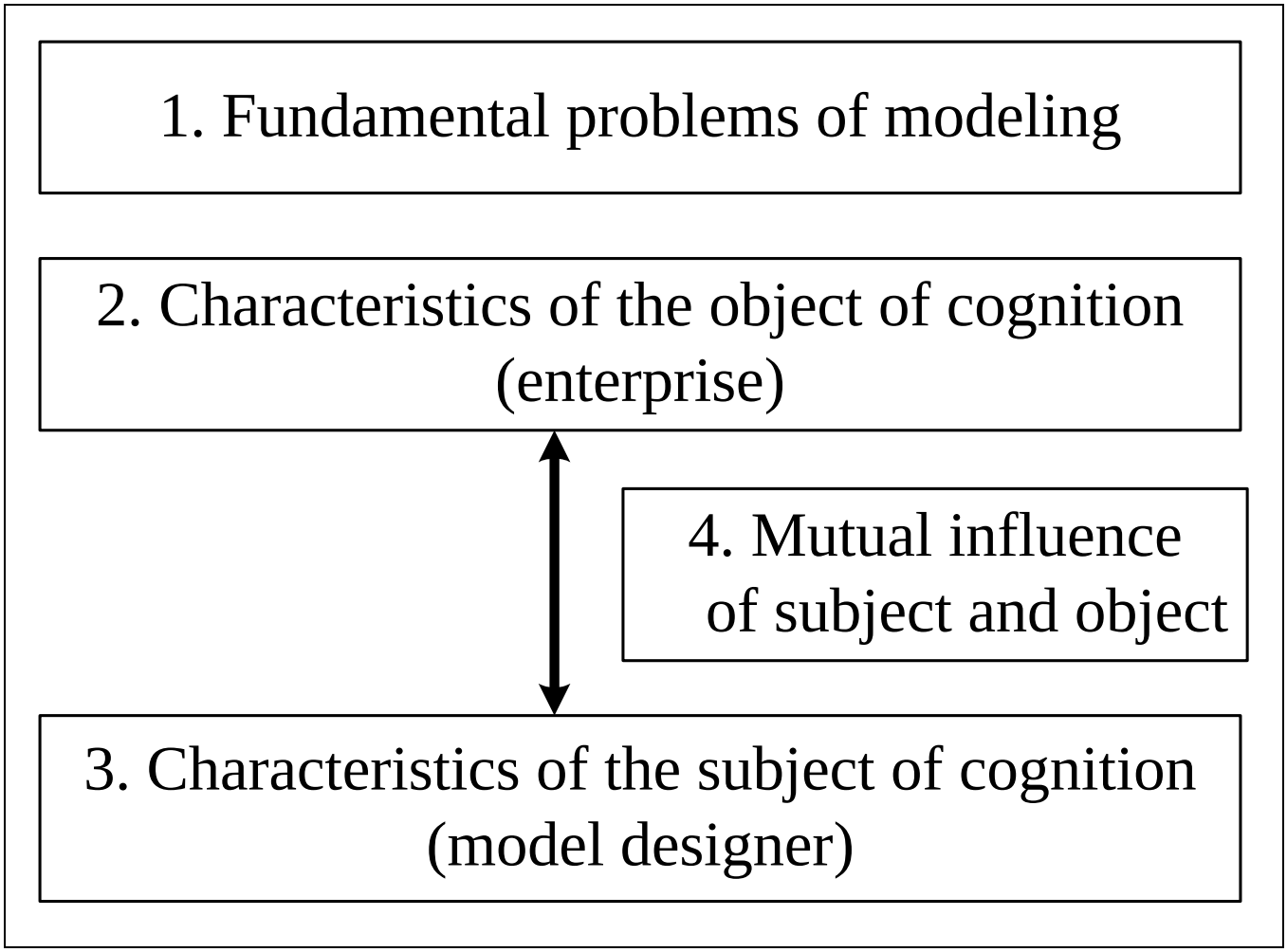
4) Subject and object of cognition are strictly separated: You can observe an organization like a table.

Ignorance of the fundamental problems with regard to models and naive and wrong expectations towards formal models are important reasons for projects going wrong.

Therefore, it is inevitable to epistemologically investigate design/development (cognitive processes), nature and limits of models.

5 Structure of the research field 1

According to the examples above, the epistemological problem field can be examined under four not completely disjoint aspects:



5 Structure of the research field 2

1) Essential problems of modeling, cognitive dilemmas

– lack of isomorphism between model and reality and impossibility of complete observation, description and modeling
– loss of information when isolating open systems
– loss of information by separating subject and object of cognition
– impossibility of complete communication (Habermas), e.g. methods of requirements engineering
– futility of models without model representations, e.g. meta-models independent of notations
– dependence of models on their model designers and on their modeling purpose

2) Properties of the object of cognition (organization)

Organizations are constituted by humans and business structures. They are open, temporally dynamic, complex, social / socio-technical information(-processing) systems.

To deploy formal IT tools in an organization environment, which is always only partly accessible to formalization, inevitably causes friction.

5 Structure of the research field 3

3) Properties of the subject of cognition (model designer)

Cognitive strategies of modeling:
– abstract(ing), comparative, analogical thinking
– multiperspective thinking (cf. ethnographic research)
– non-linear, parallel and associative thinking
– gestalt-theoretical principles:
(re-)construction, isolation and decomposition of structures
– selective perception determined by prior knowledge and by the modeling purpose
foreground-background picture, map turned by 90°
– thinking in structured cognitive processes:
mayeutic cycle, experiencial learning method, phase concept

4) The mutual influence (interaction) of subject and object of cognition (model designer and organization)

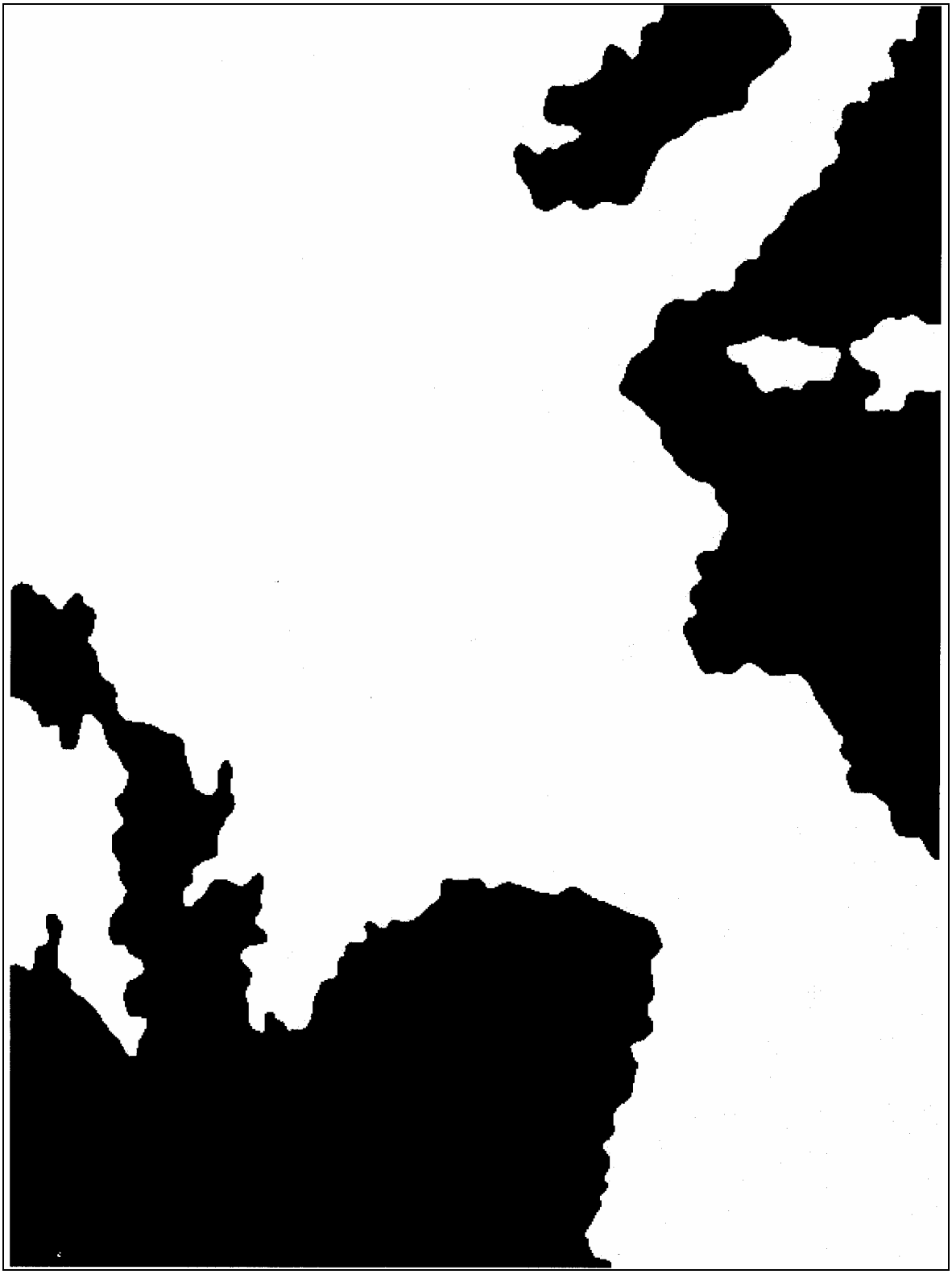
Organizations are open, temporally dynamic, complex, social / socio-technical information(-processing) systems which perceive any kind of observation and change their behavior under observation.

Vice versa, the observer is influenced by the organization.

Subject and object of cognition together form a new open system of cognition where observation is executed.

5 Structure of the research field 4

3) Properties of the subject of cognition (model designer)



6 Conclusion: type and effect of the results

The epistemological problem field is independent of model representations, notations, technologies and implementations.

Many aspects of the epistemological problem field are
– essential problems
– not solvable

If model designers are aware of those problems,
undesired effects can be reduced considerably.

In order to exhaust this potential of improvement
it is necessary
to investigate and understand the epistemological problem field in a lot more details beyond the known aspects.

This is a wide research field and a great research challenge.

Outlook:

Discussion of epistemological approaches:

- **Karl Popper's ontological theory of the three worlds**
- **critical realism**
- **evolutionary epistemology (K. Lorenz, R. Riedl, G. Vollmer)**
- **constructivism**

Discussion of the research field in detail

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pdf-files of my own publications: see my homepage.

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