Alfred Holl

Epistemology and methodology in enterprise modeling and information systems modeling

Brief description

Epistemology is the branch of philosophy which deals with the acquisition (cognitive processes), nature and limits of knowledge, especially scientific knowledge, such as formal (mathematical) models. Models of that kind inevitably form the necessary basis for business information systems.
Regarding Information Systems as an empirical science, the formal models used are the results of cognitive processes which always lead to a difference and a conflict between reality and model. Every computer scientist should be aware of this fact and renounce naïve realism, that is, the assumption of a one-to-one correspondence between reality and model, in favor of positions which are of special value for the epistemological judgment of information systems modeling.
Although there is no single all-encompassing result, which can be formulated in one sentence, there are a lot of partial results. In essence, we can say that while it is true that knowledge of epistemological connections does not eliminate the fundamental epistemological problems, it does, however, considerably reduce their undesired effects.
Detailed texts and slides in English are available on my homepage http://www.informatik.fh-nuernberg.de/professors/holl/Personal/HollHome.htm via the link "Publications and Manuscripts".

Contents

Epistemology	Information systems issue
1 <u>Epistemological issues of modeling</u>: relation between reality and models, model designers	**Epistemological judgment of IS models and the circumstances of their design**
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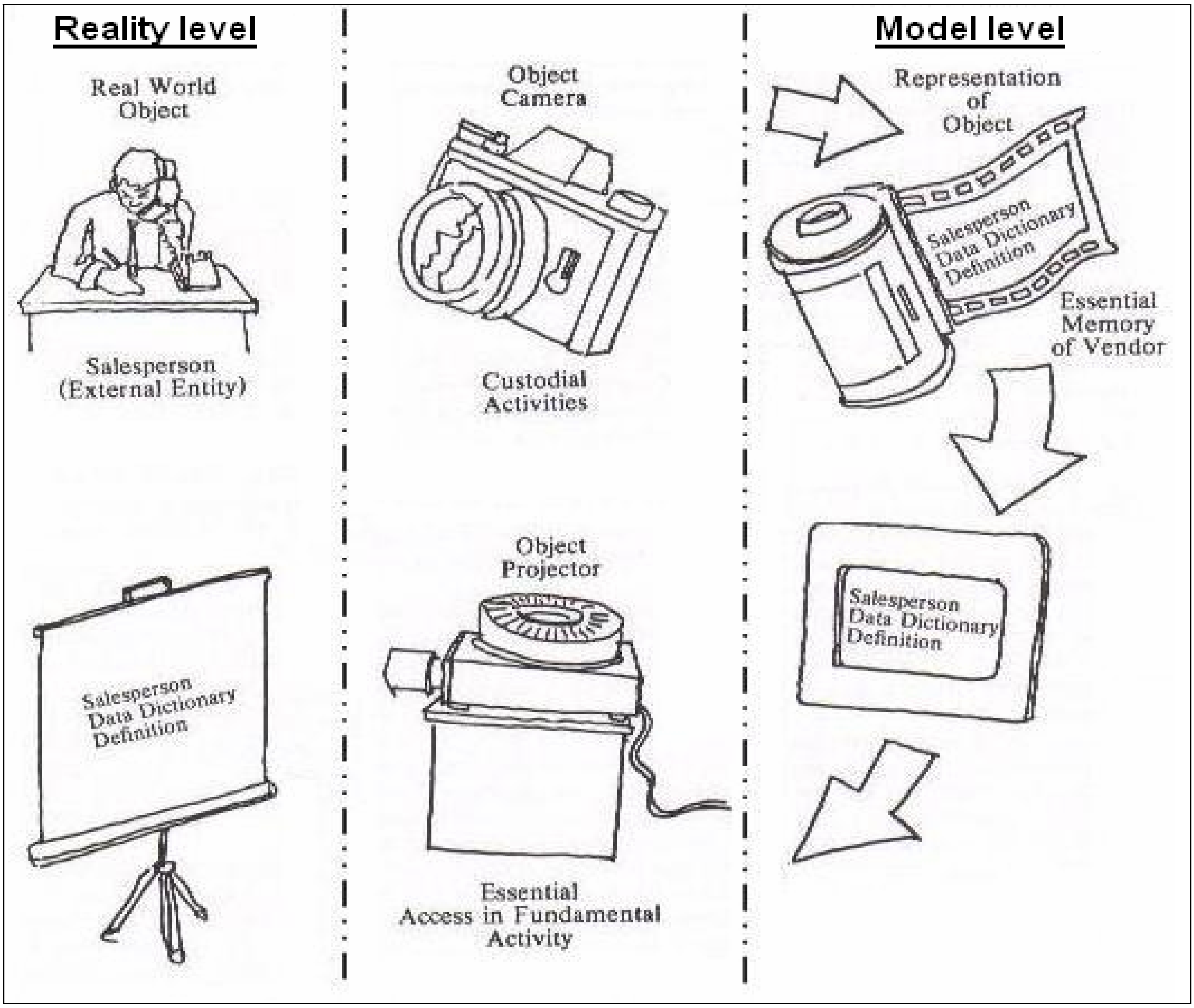
3 <u>Principles of modeling</u>: model levels, model purposes, structuring of a modeling process	**Relation between IS and business, modeling on business and IT (design) levels, model purposes, phase concepts**
4 <u>Popper</u>'s epistemological meta-model	**Difference reality – model, model designers**
5 <u>Epistemological approaches</u>: critical realism, evolutionary epistemology, constructivism, epistemological step model	**Selection of an adequate epistemological approach for IS modeling**
6 <u>Empiristic approaches</u> to modeling: formal models, structured cognitive (knowledge-acquiring) processes (induction, deduction, mayeutic cycle)	**Systems analysis and requirements engineering in iterative software life cycle models (phase concepts) , starting points for modeling**
7 <u>Rationalistic approaches</u> to modeling: analogical thinking and type construction	**Generic models, reference models**

(8 <u>Problem / systems analysis</u>: problem of isolation, qualities of the object of cognition (in-homogeneity, heteronomy, temporal dynamics, chaotic behavior)	**Details of the analytical phase in a phase concept of IS development, requirements engineering, pre-formalization, effort for formalization, accessibility / suitability to formalization / structuring**
(9 <u>Meta-models</u> of modeling approaches from different perspectives	**Meta-models of IS modeling approaches, notations of IS modeling approaches**
10 <u>Structured behavioral models</u>, theory of gestalt	**Structured business process modeling, feature-oriented business process models**
11 <u>Cooperative cyclic knowledge gain</u>: empirism and rationalism joined in a mayeutic cycle	**Information systems anti-aging, Software Evolution (Manny Lehman), SW maintenance, changed requirements management, open models**
12 <u>Research methods</u>	**IS research methods, qualitative and quantitative methods, design theory, action research, interactive research etc.**
13 <u>Guidelines</u> for scientific papers	**Preparation for the D-thesis**

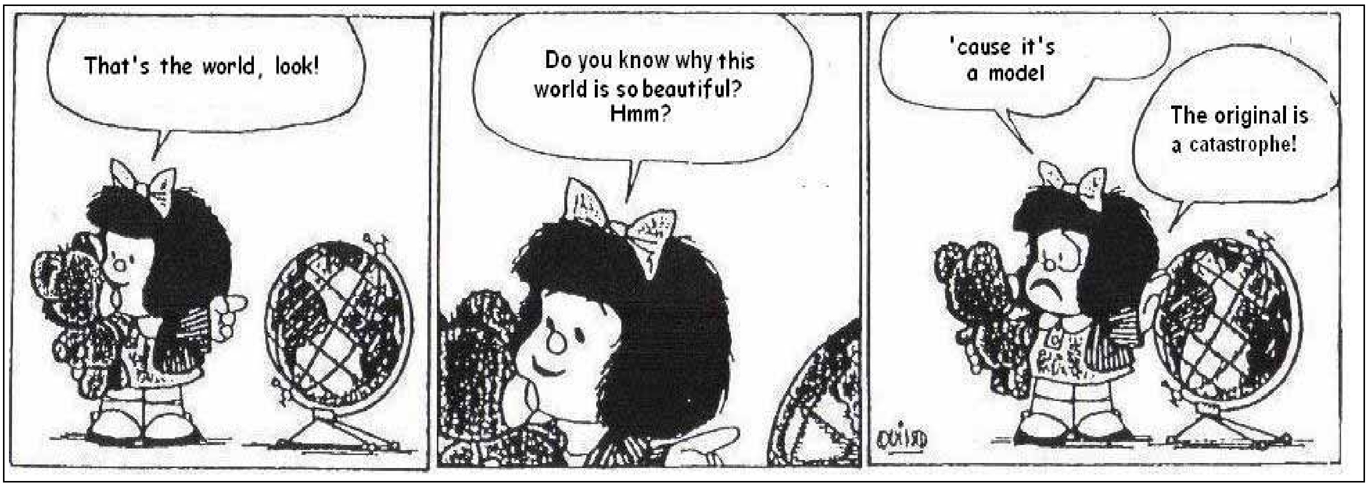
1 Epistemological issues



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

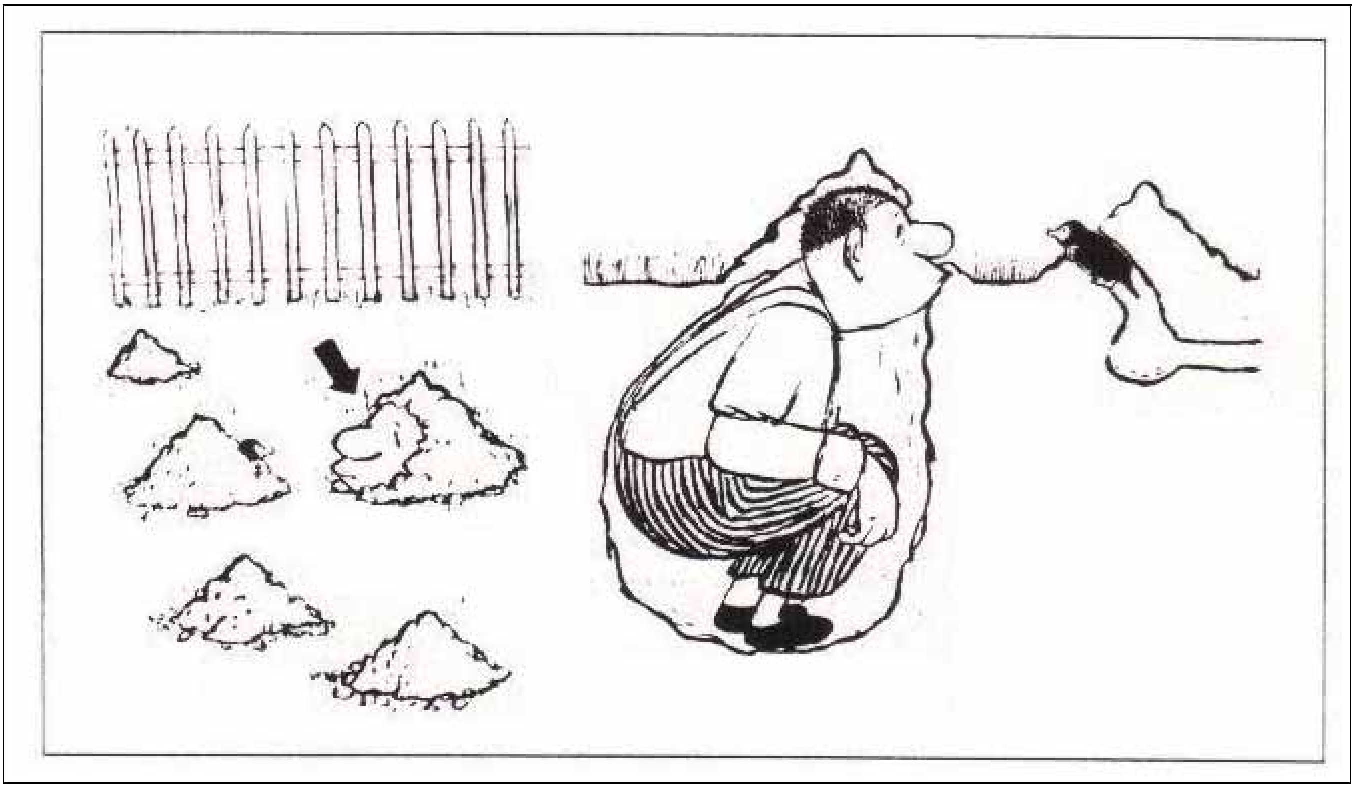
1) Essential problems of modeling, cognitive dilemmas
2) Properties of the object of cognition (enterprise)
3) Properties of the subject of cognition (model designer)
4) The mutual influence (interaction) of subject and object of cognition (model designer and enterprise)

1) The problem of isomorphy



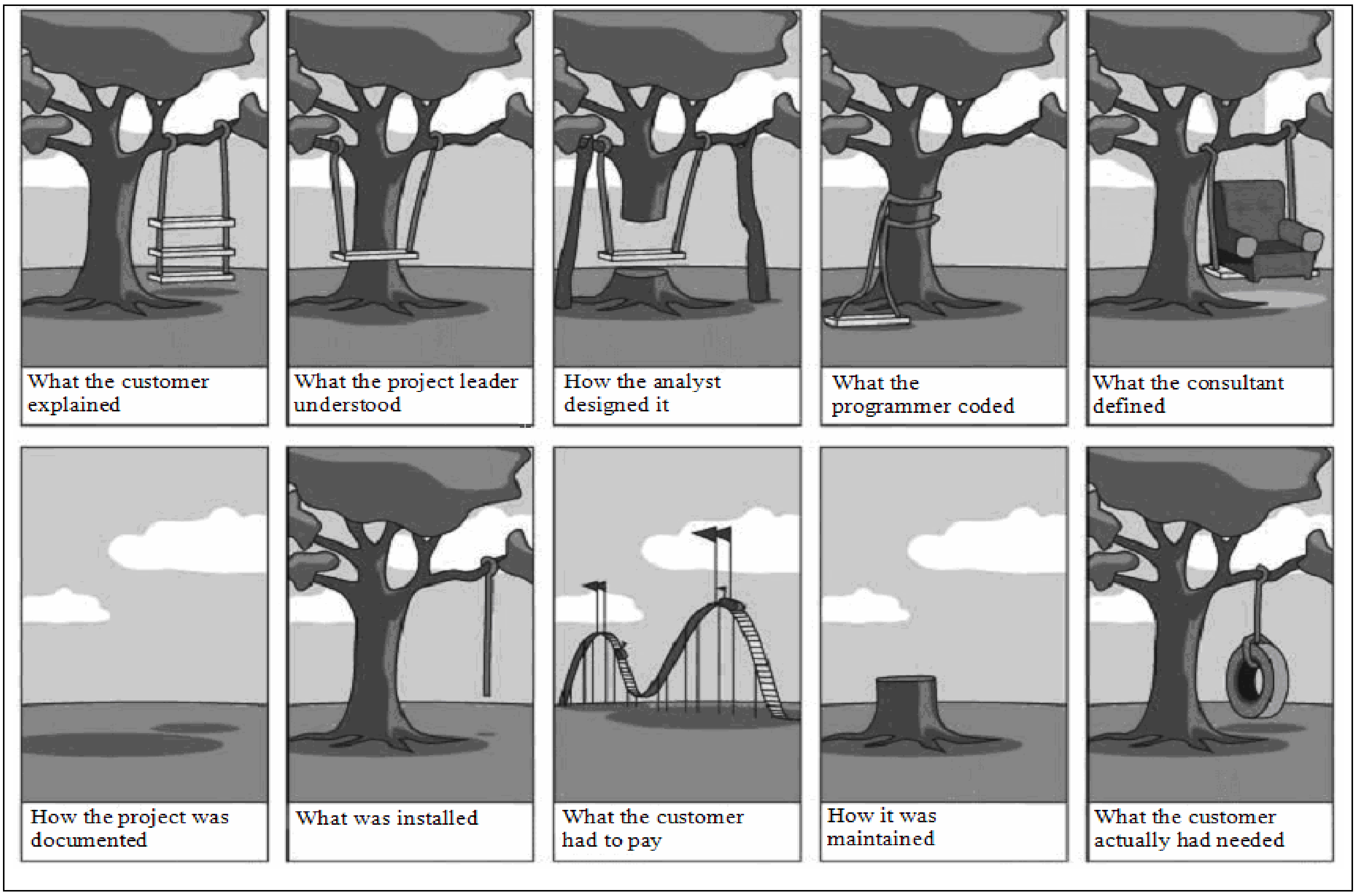
Girl and globe
(Quibeldey-Cirkel, Objekt-Paradigma, 1994, 15)

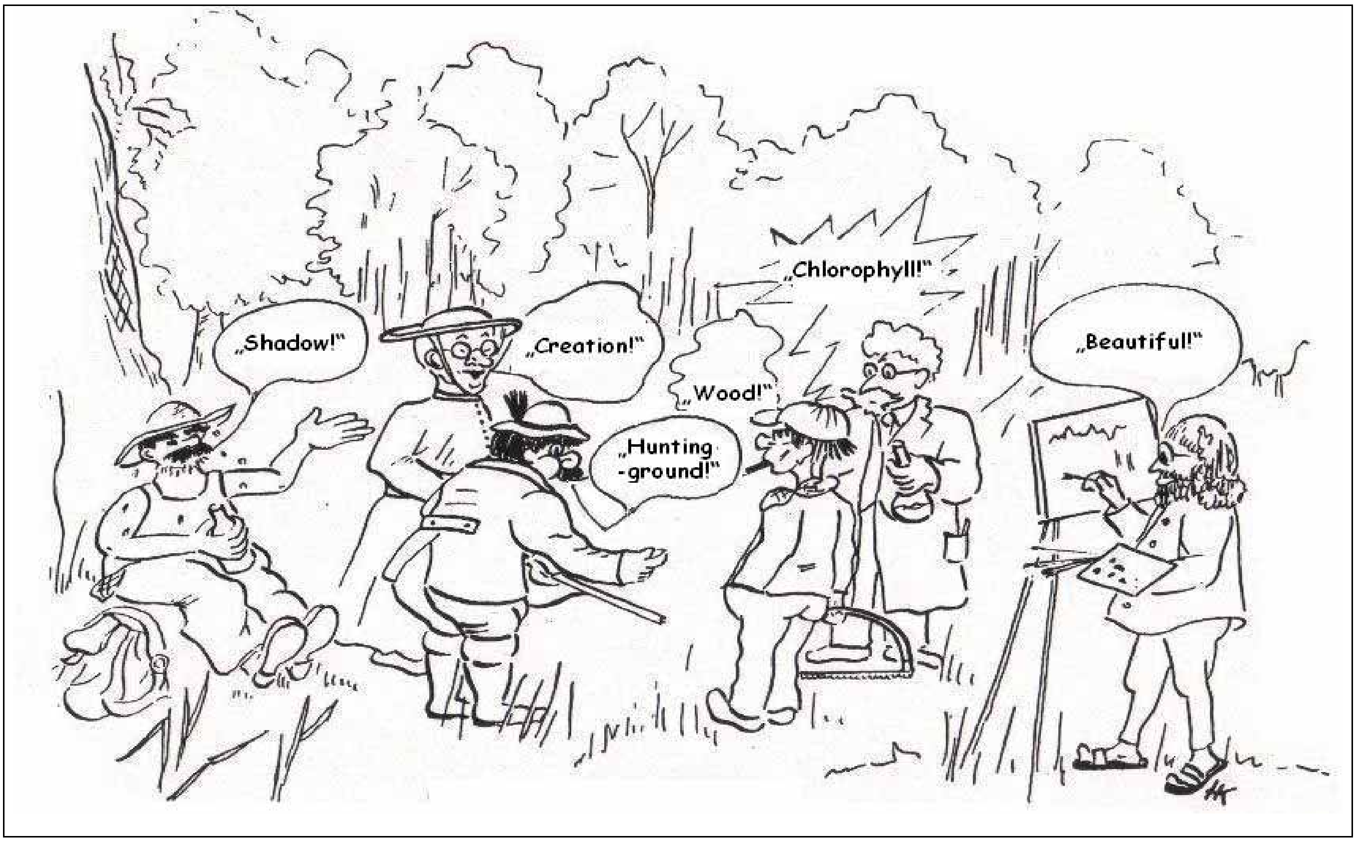
4) The influence of model designers on the enterprises observed



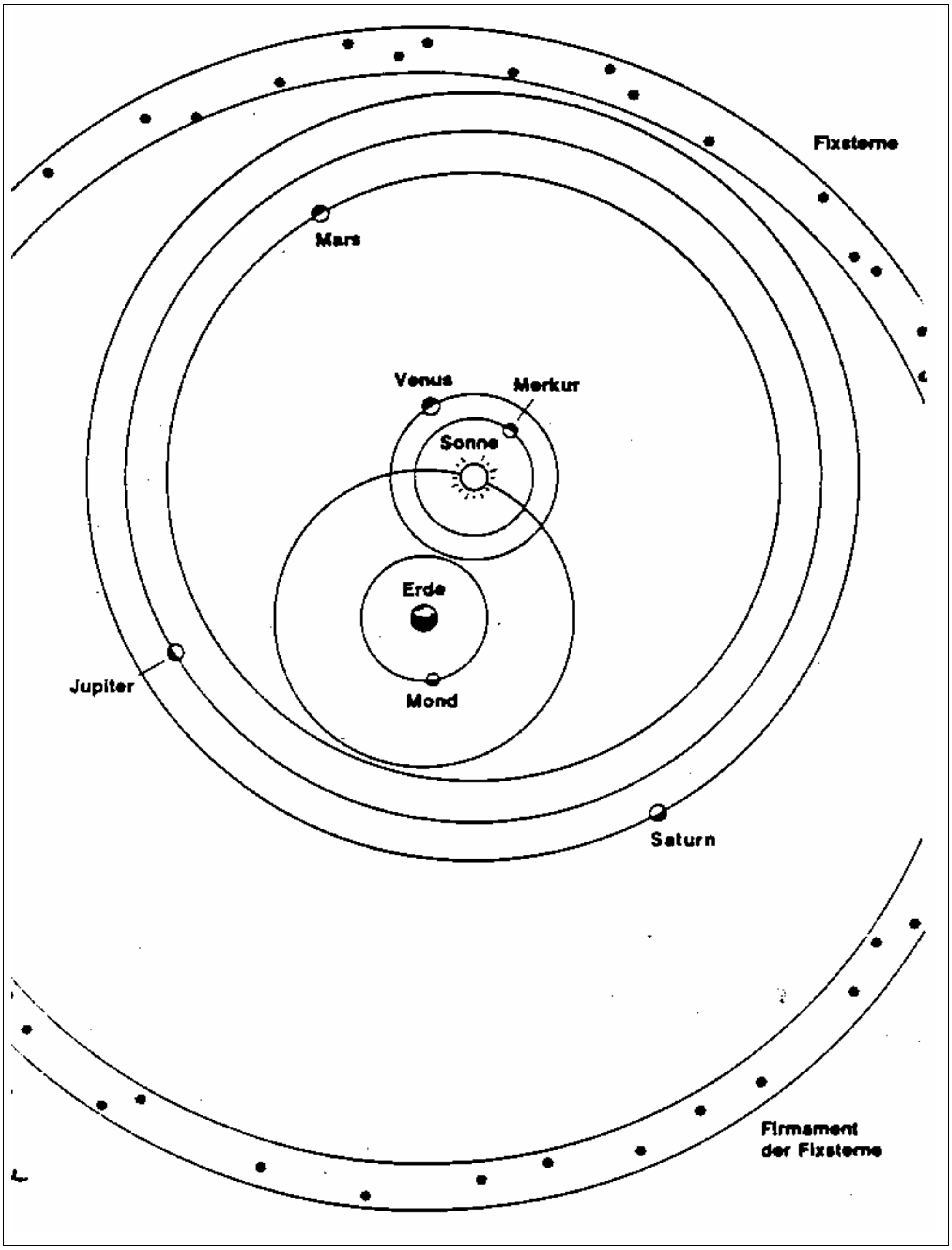
Ethologist and mole
(Loriots großer Ratgeber, 1968, 219 quoted from Schmidt, Simulation in Passau, 1993, 2, 12)

2 Multi-perspectivity





Forest (Hajos, Wahrnehmungspsychologie, 1991, 18)

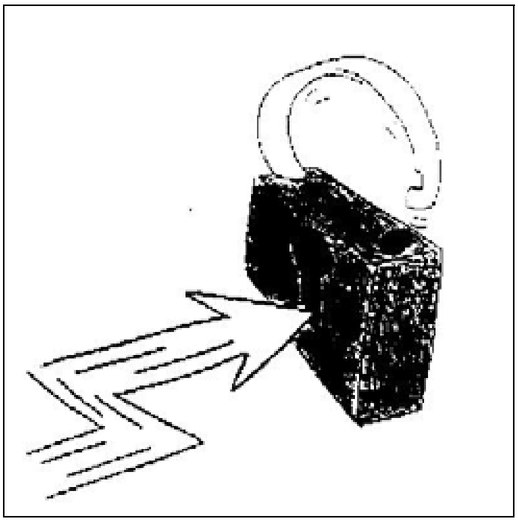


Model of the solar system by Tycho Brahe (1546-1601)
(Fuchs, Bevor die Erde sich bewegte, 1975, 140)

Exemplary story of 'The blind men and the elephant'

3 Principles of modeling

A good IS and its application area fit together like key and lock:

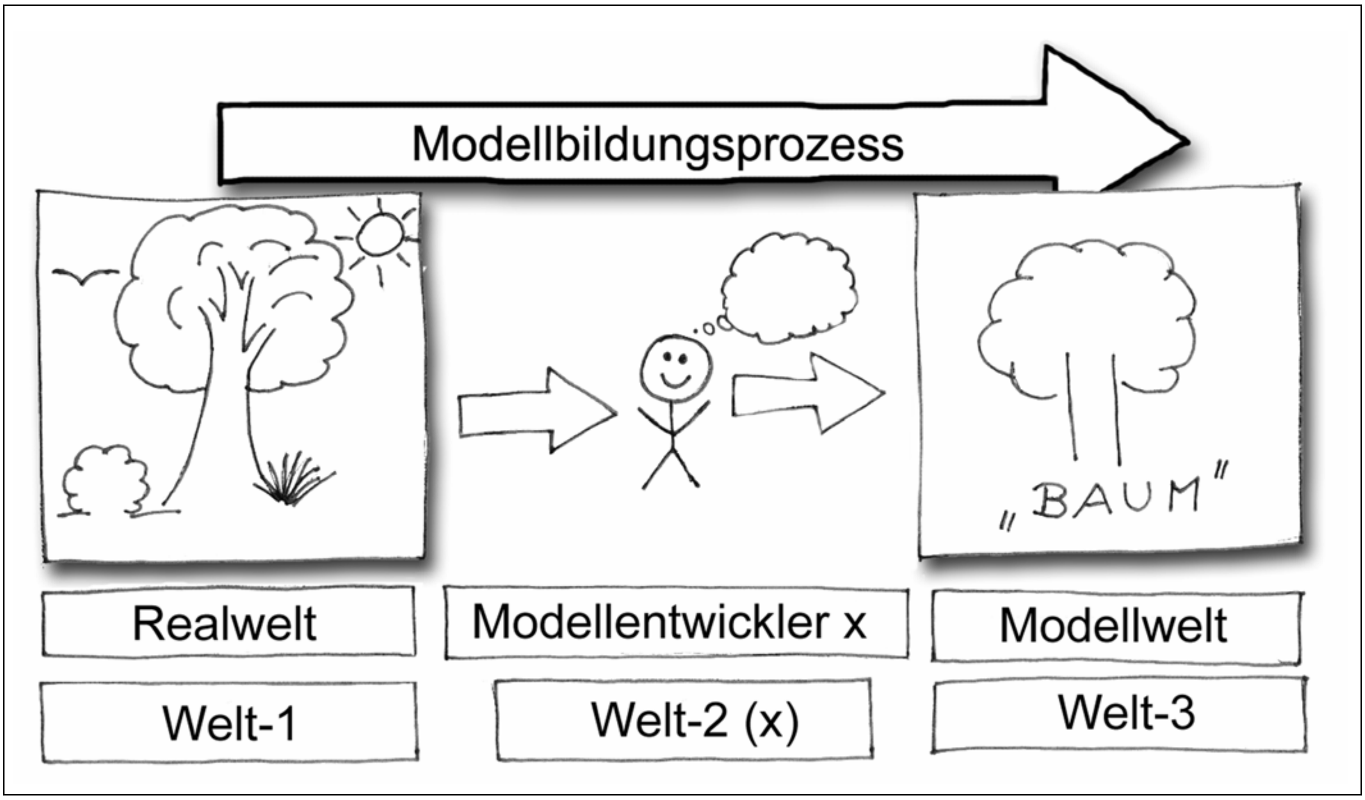


lock: organization level
key: information-relevant IS level
key: implementation-relevant IS level

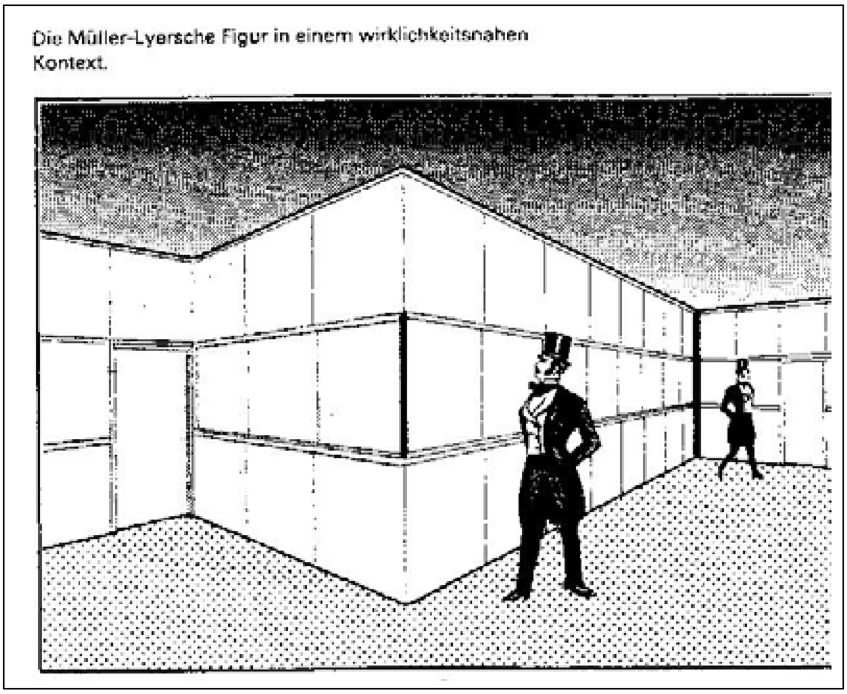
An IS cannot cure the disastrous management of an organization.
A straight key cannot be put into a crooked lock.

main phase	subphase	model level	model purpose
analytical phase: problem analysis	**elicitation of the current state of the organization**	**information-relevant models**	**descriptive models (systems analysis)**
	analysis of the current state of the organization		
	design of the planned state of the organization (LOCK)		**prescriptive models (requirements engineering)**
	design of the business concept of the IS (KEY)		
synthetical phase: IT system development	**design of the technical concept of the IS**	**implementation-relevant models**	
	programming		
	test		
	use	**information-relevant models**	
maintenance			

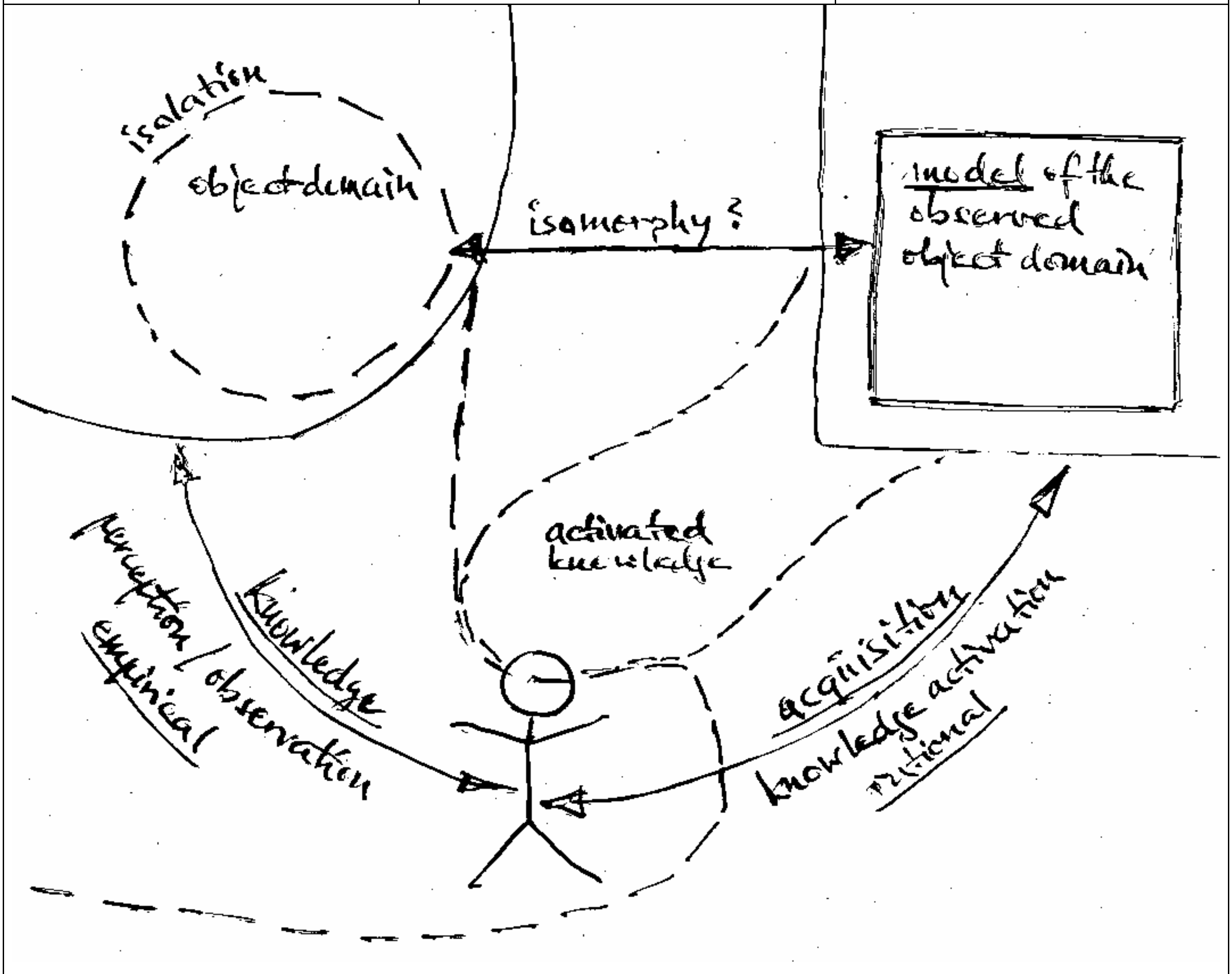
4 Popper's epistemological meta-model



(Holl / Krach, Ubiquitärer naiver Realismus, 2002, 54)

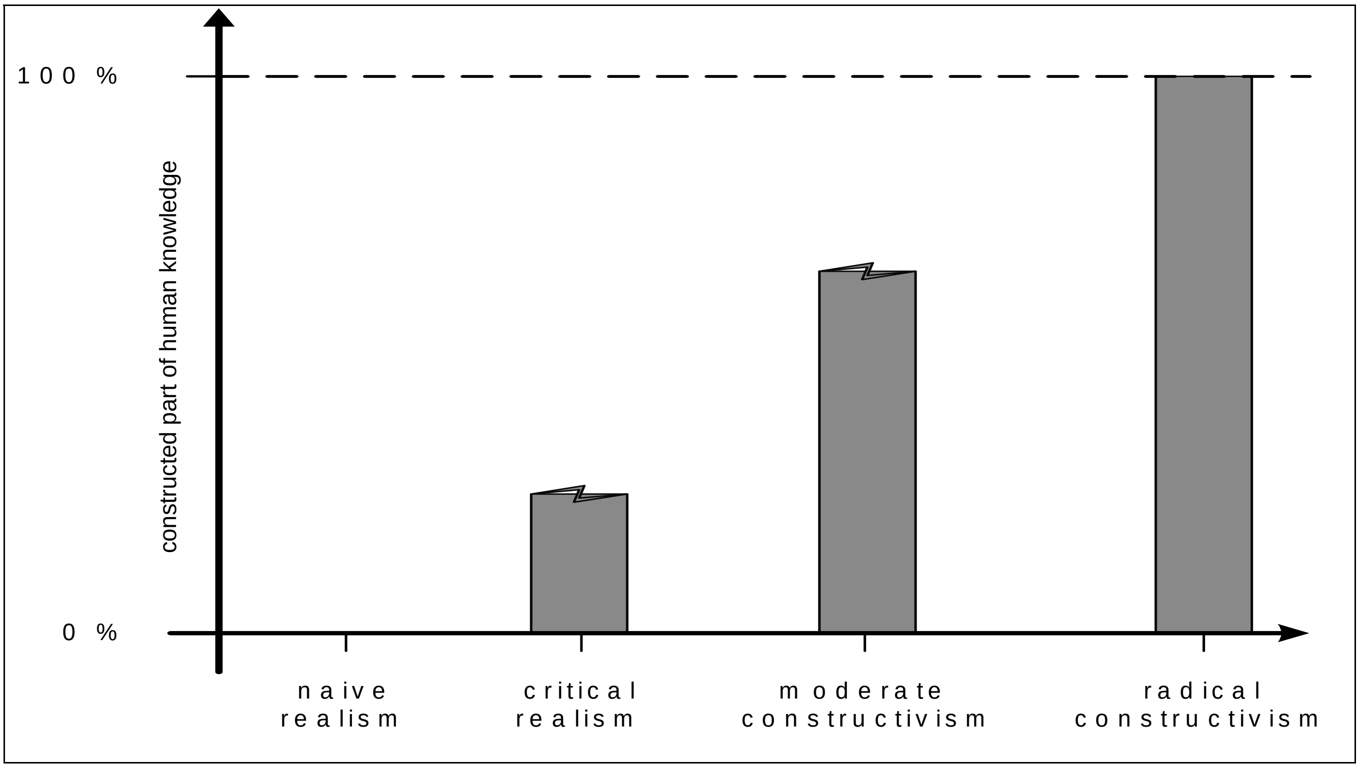


To better understand Popper's idea of World 2:
Müller-Lyer's optical illusion (Rock, Wahrnehmung, *, 139)**

<table>
<tr><td>World 1:
sensory</td><td></td><td>World 3:
mental</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td></td><td>World 2
individual researcher
model designer
consciousness</td><td></td></tr>
</table>

“Hand-made” diagram showing the epistemological situation

5 Epistemological approaches

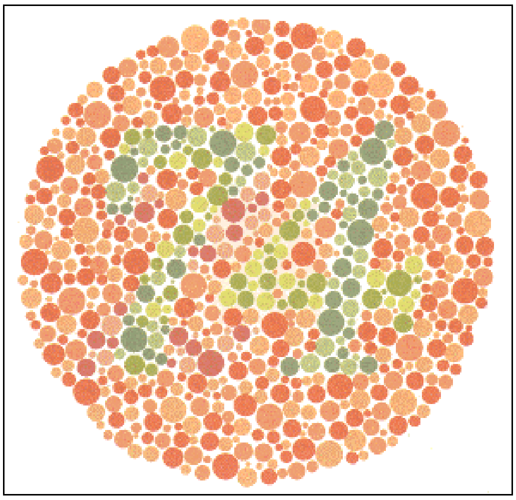


(Holl / Maydt, Epistemological foundations of RE, 2007, *)**

Relation reality – model	Epistemological approach	Scope in a step/layer model
1 to 1	naive realism	simple objects in the physical world
a certain	critical realism, moderate constructivism	complex objects, optical illusions, sub-atomic particles, enterprises, economy, human society
	evolutionary epistemology	special explanatory value
no	radical constructivism	speculations, psychiatry

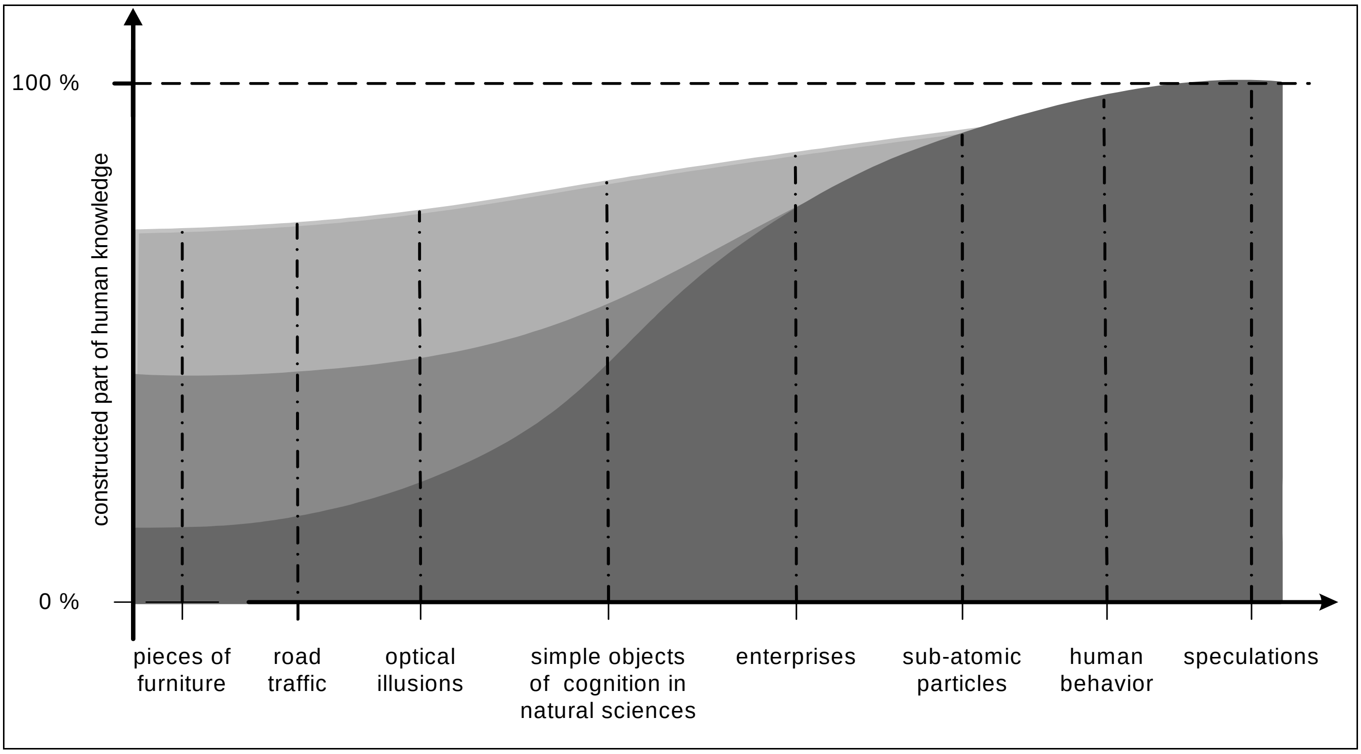
Discrete epistemological step model: simplest adequate approach; can be replaced by a continuous model (no hard boundaries)

Every (re-)construction (interpretation) of reality is determined by <u>biological and social norms of perception</u> and, therefore, always contains some <u>constructed part</u>.
Example: color blindness



Ishihara table

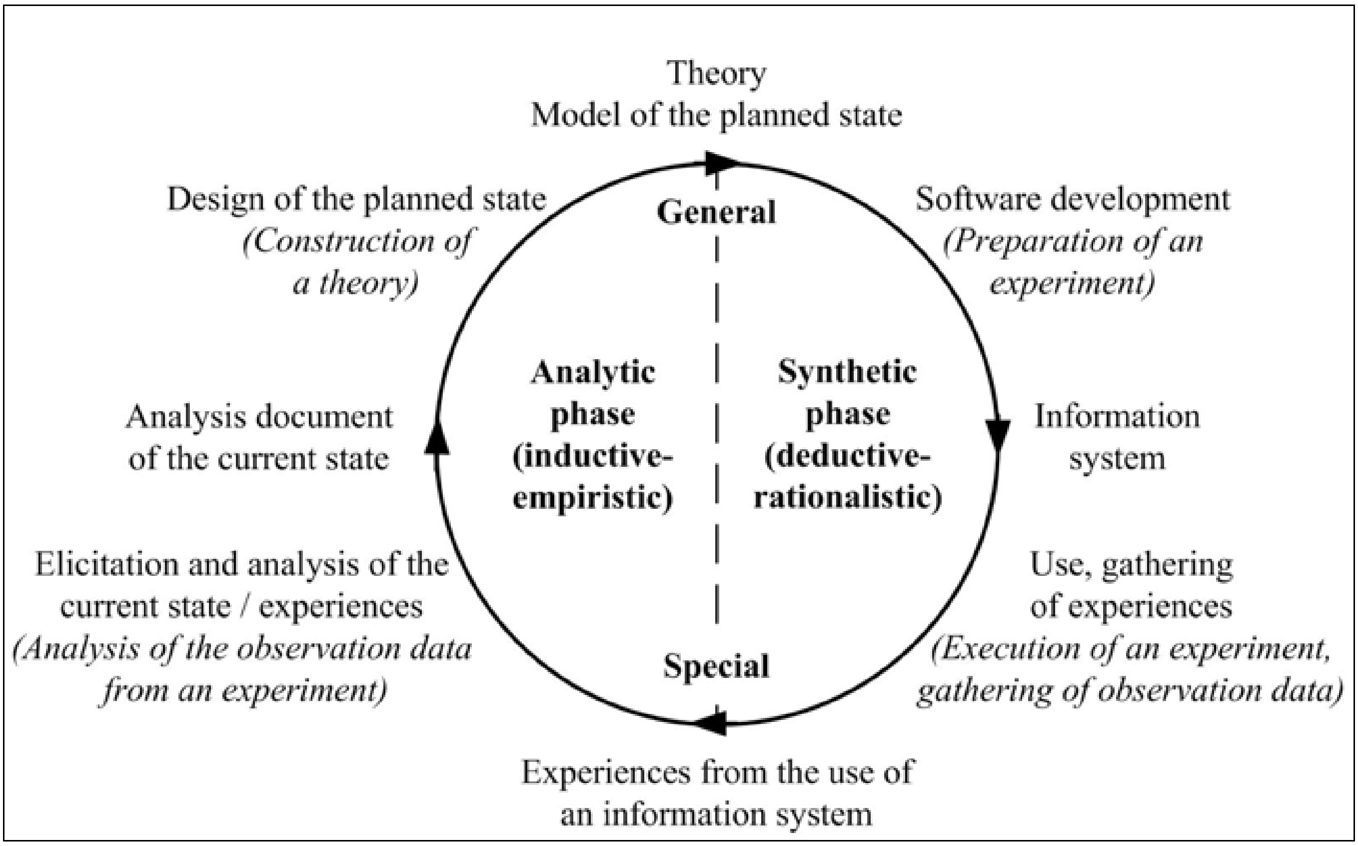
The size of the constructed part can only be determined relatively.



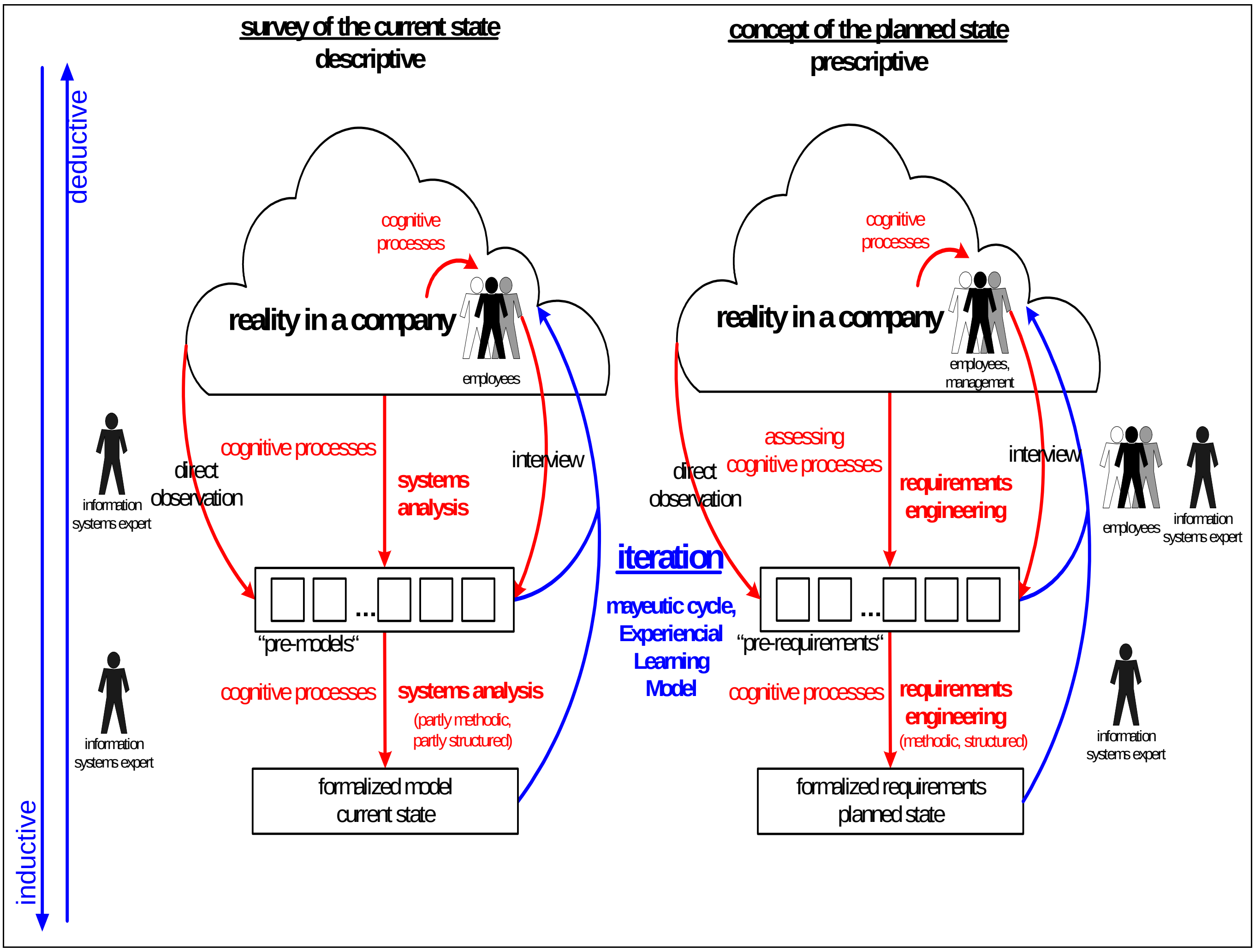
(Holl / Maydt, Epistemological foundations of RE, 2007, *)**

6 Empiristic approaches

	natural sciences	IS
object of examination	object of cognition in the nature	information handling processes in enterprises
manner of examination	observation	observation
utilization of the observation results	process of model construction	process of model construction
result of the process of model construction	formal model: formula	formal model: data model, information flow model, business process model
direct purpose	mathematical description	construction of system designs for IS
indirect use	explanation, understanding	optimization of information handling processes
transferability	prediction	reference models



Mayeutic cycle in IS and natural sciences
(Holl / Paetzold / Breun, IS anti-aging, 2008)



Cognitive processes in IS modeling
(Holl / Maydt, Epistemological foundations of RE, 2007, 53)

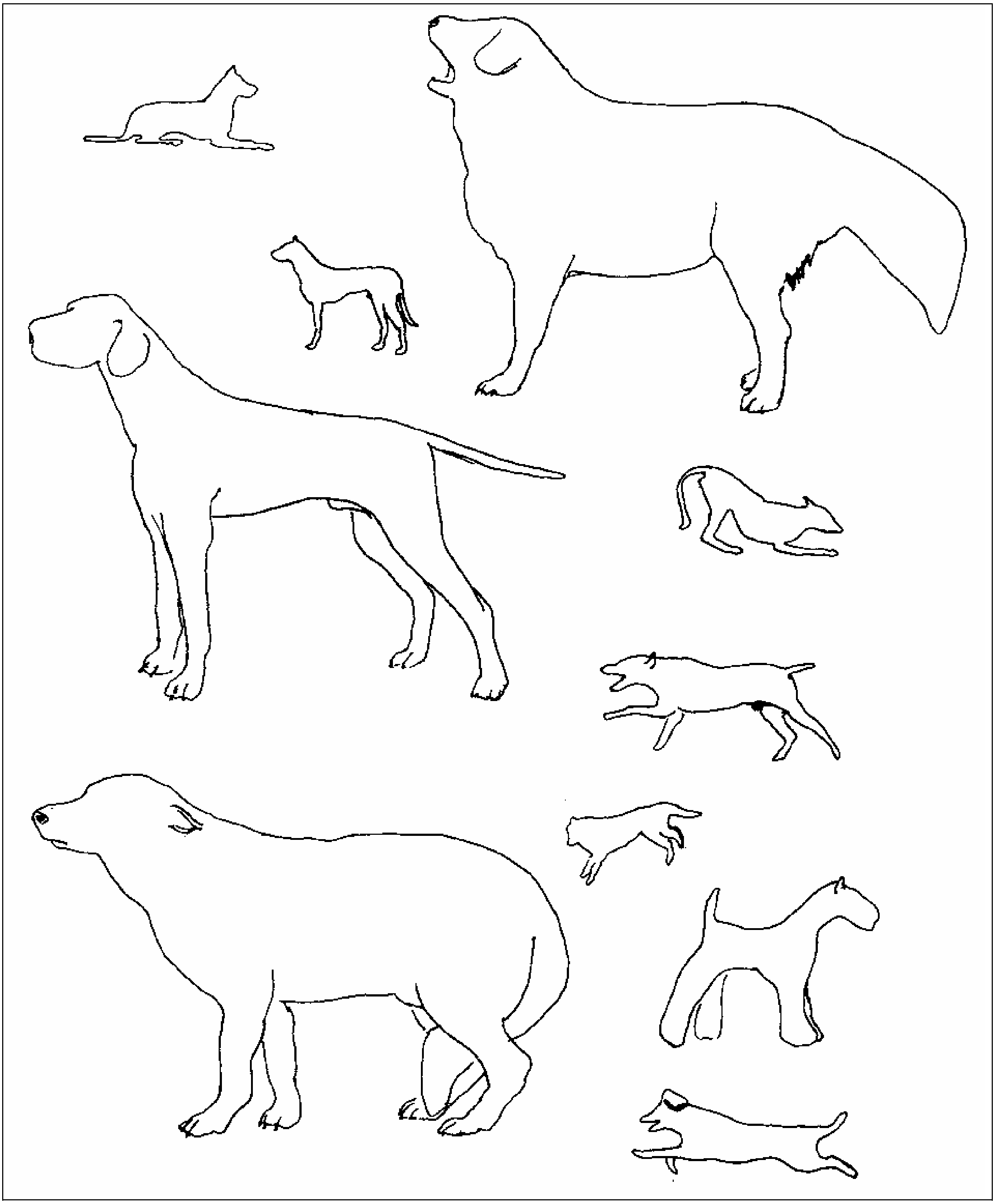
level	partly methodic, partly structured	epistemology-based	epistemological foundation
eliciting the current state	systems analysis	(missing)	systems theory
designing the planned state	business concept modeling	requirements engineering	linguistics, psychology, …

Cognitive methods in information systems
(Holl / Maydt, Epistemological foundations of RE, 2007, 54)

7 Rationalistic approaches

external world ↓ **<u>World 1</u>** **objects of cognition**	**phenomenon, individual experience** ↓ **<u>World 2</u>** **knowledge of an individual subject of cognition**			**model, theory** ↓ **<u>World 3</u>** **common knowledge**
	perception, cognitive processes (empiristic) ↓ **<u>reconstruct.</u> of World 1** →	**<u>memory</u>**	**learning** **rationalistic** ↓ **<u>activations</u> of World 3** ←	
←	↓ **creation, induction** ↓ **design, influence** ← **new ideas, knowledge** → **publi-cation**			→

Two sources for model construction in IS



**Analogical thinking and perception of gestalt:
assignment of individuals to a type using key features
(Wuketits, Entdeckung des Verhaltens, ***)**

creditor	**debtor**	**umbrella terms generic model**
supplier groups ↓ **suppliers** ↓ **outgoing orders** ↓ **order lines** ↑ **raw materials** ↑ **material groups**	**customer groups** ↓ **customers** ↓ **incoming orders** ↓ **order lines** ↑ **products** ↑ **product groups**	**business partner gr.** ↓ **business partners** ↓ **orders/contracts** ↓ **order lines** ↑ **items** ↑ **item groups**

Example for a reference model
(→ one-to-many relationship)

10 Structured behavioral models

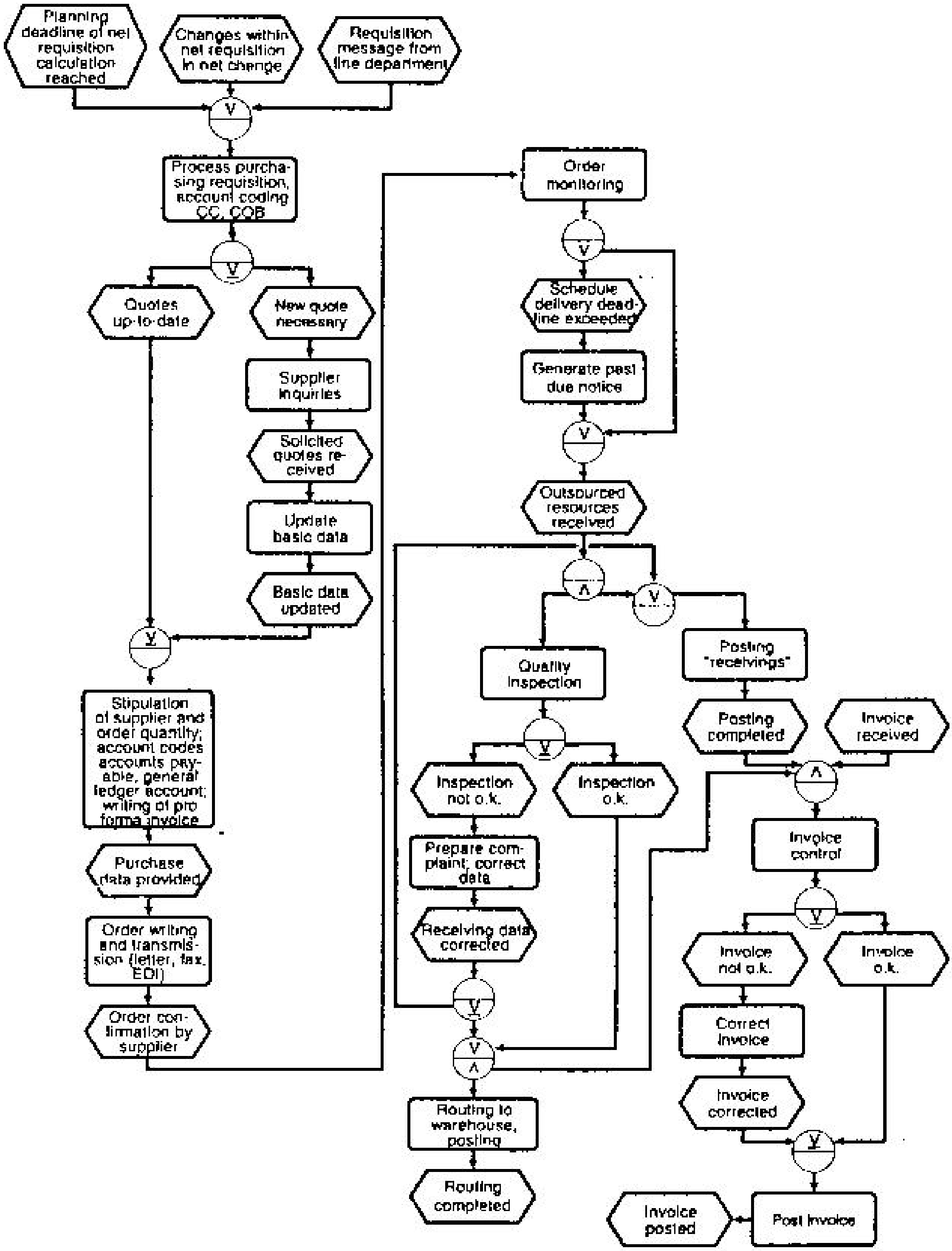


Fig. B.II.09: Event-driven process chain for inbound logistics

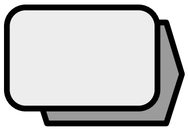
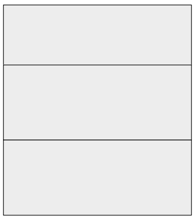
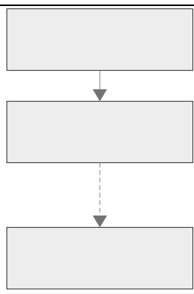
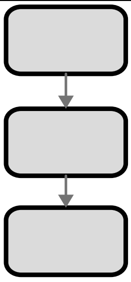
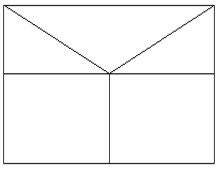
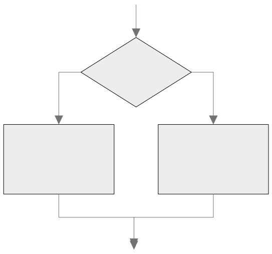
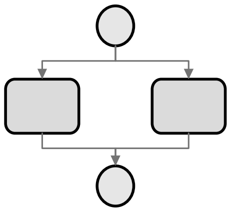
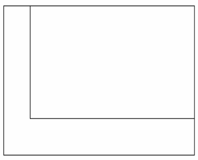
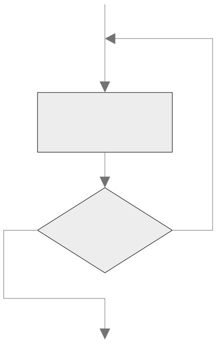
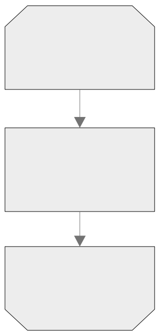
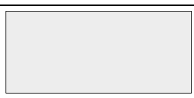
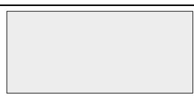
(Scheer, Business Process Engineering, 1994, 404)

Control flow modeling styles		BPM styles	
1950s 1960s	Spaghetti code programming and spaghetti design	late 1980s	Spaghetti BPM
early 1970s	Structured programming and structured design	2005 ?	Desire: Structured BPM (not only in WFM)

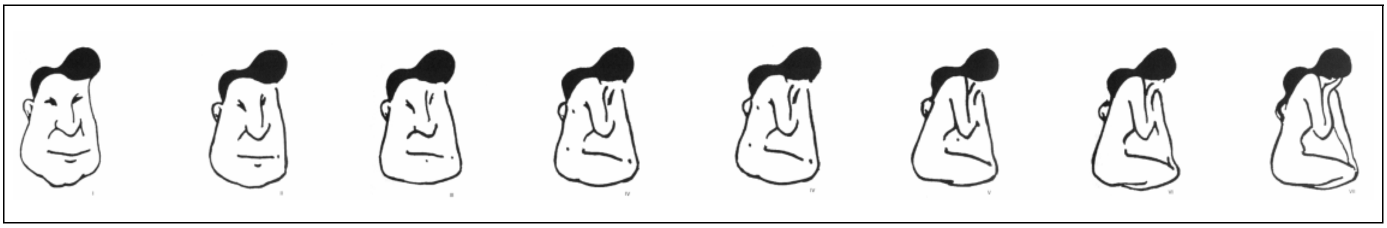
Historic comparison
(Holl / Valentin, Structured BPM, 2004)

Umbrella term	BPM	Control flow modeling
Sequence	sequence	sequence
Test, alternative, decision	XOR	IF
Iteration	cycle	loop
Event	business event	operating system event, interrupt
Process unit	business activity	instruction or block of instructions
Modular substructure	partial process	subprogram, subroutine
Simultaneity	AND	parallel functions

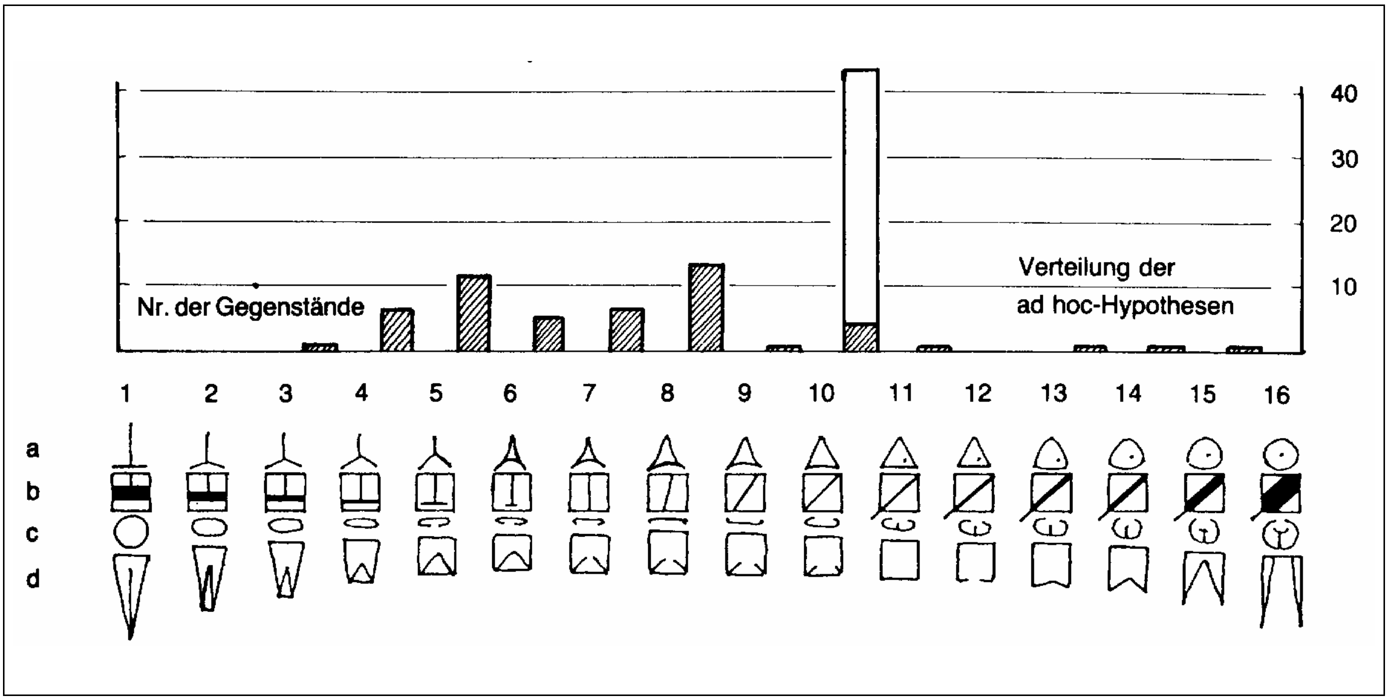
Analogy (umbrella terms) of the elementary components of BPM and control flow modeling
(Holl / Valentin, Structured BPM, 2004)

Umbrella term	Structure diagram (DIN 66 261) according to Nassi-Shneiderman	Control flow chart (DIN 66001)	Control flow chart: extensions of DIN 66001	Event driven process chain (EPC)
Modular substructure				
Sequence				
Alternative, decision				
Iteration: DO-WHILE, REPEAT-UNTIL, WHILE				No symbol
Event	No symbol	No symbol		
Process unit				

Analogy of the notations of BPM and control flow modeling (Holl / Valentin, Structured BPM, 2004)



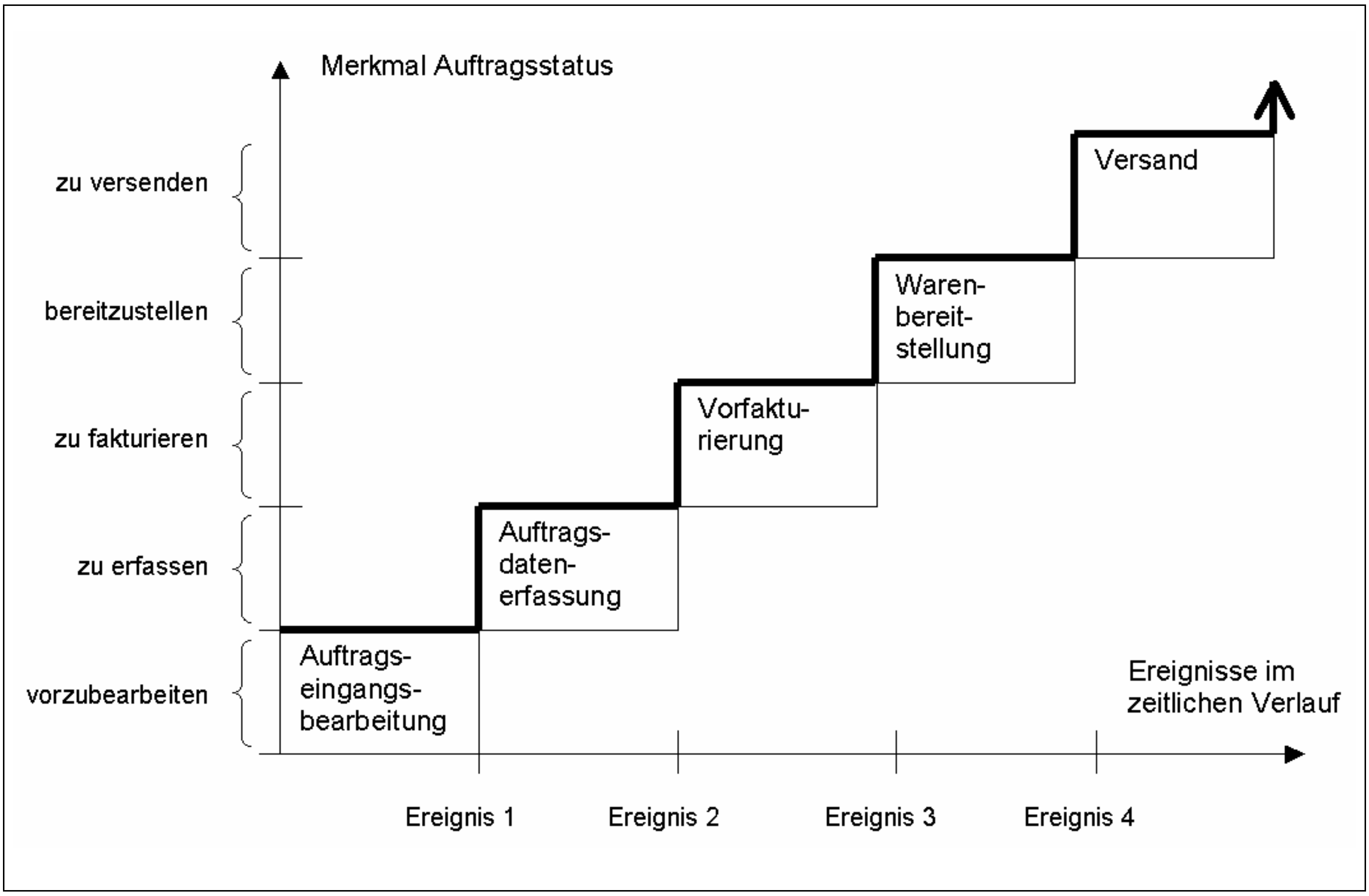
A man's face to a woman's body
(Riedl, Begriff und Welt, 1987, 74-77)



Splitting of a process according to changes of features
(Riedl, Begriff und Welt, 1987, 195)

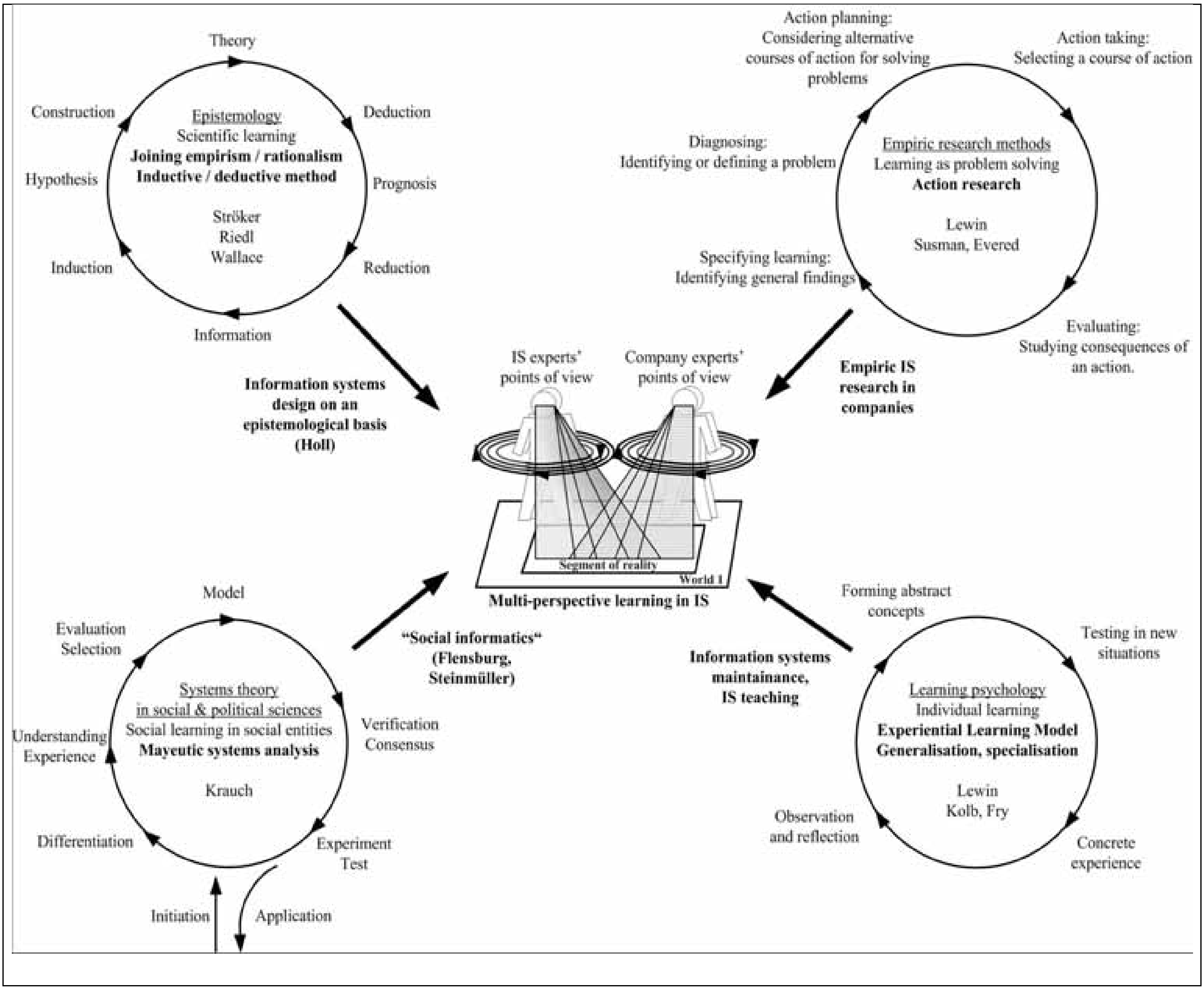
Sub-processes	Values of the feature "order status"
Order acceptance check	To be checked
Order data recording	To be recorded
Invoicing	To be invoiced
Commissioning	To be commissioned
Shipping	To be shipped

Sub-processes and their feature values

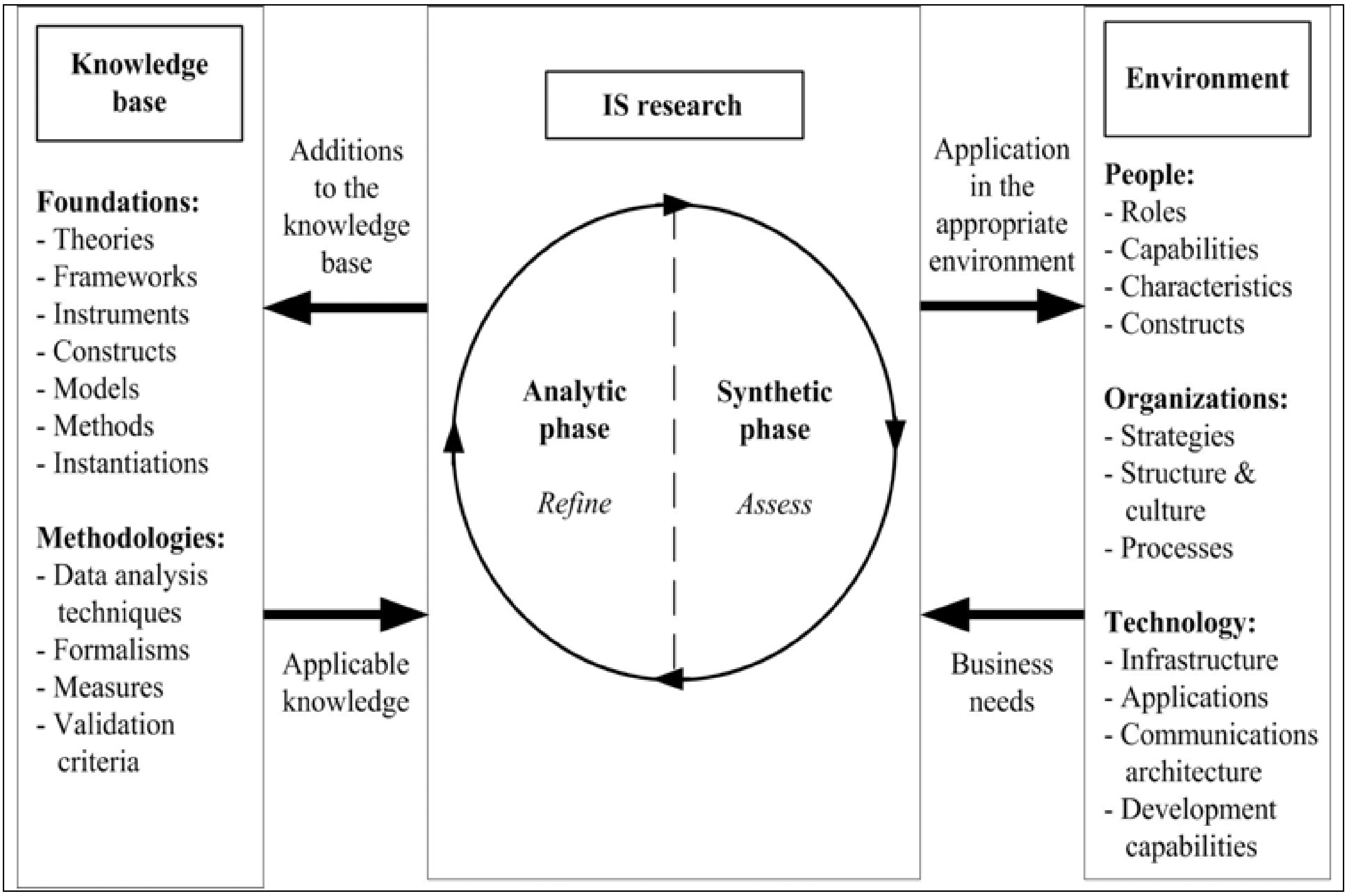


Changes of a feature visualized as mathematical step function (Holl / Krach / Mnich, Geschäftsprozessmod., 2000, *)**

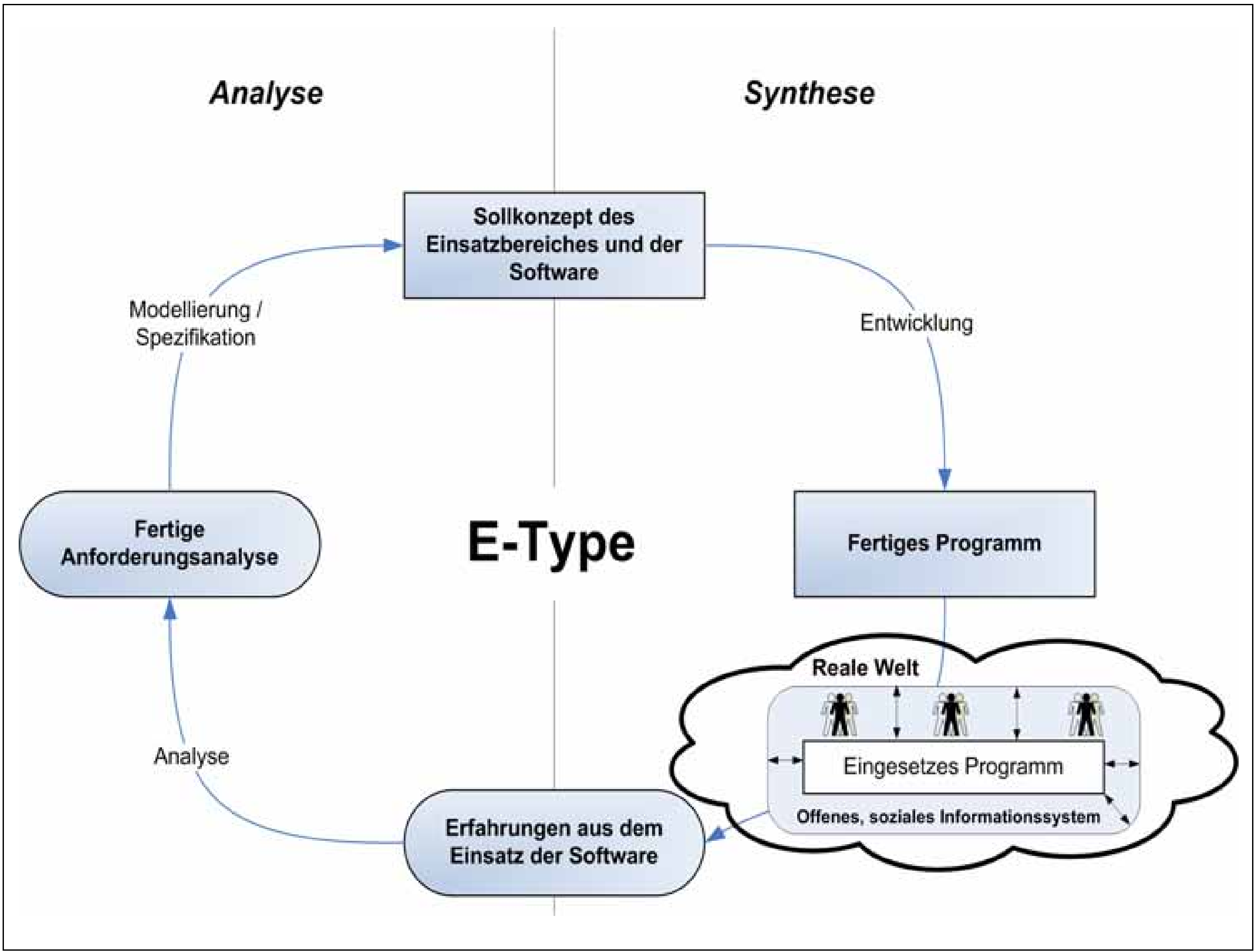
11 Cooperative cyclic knowledge gain



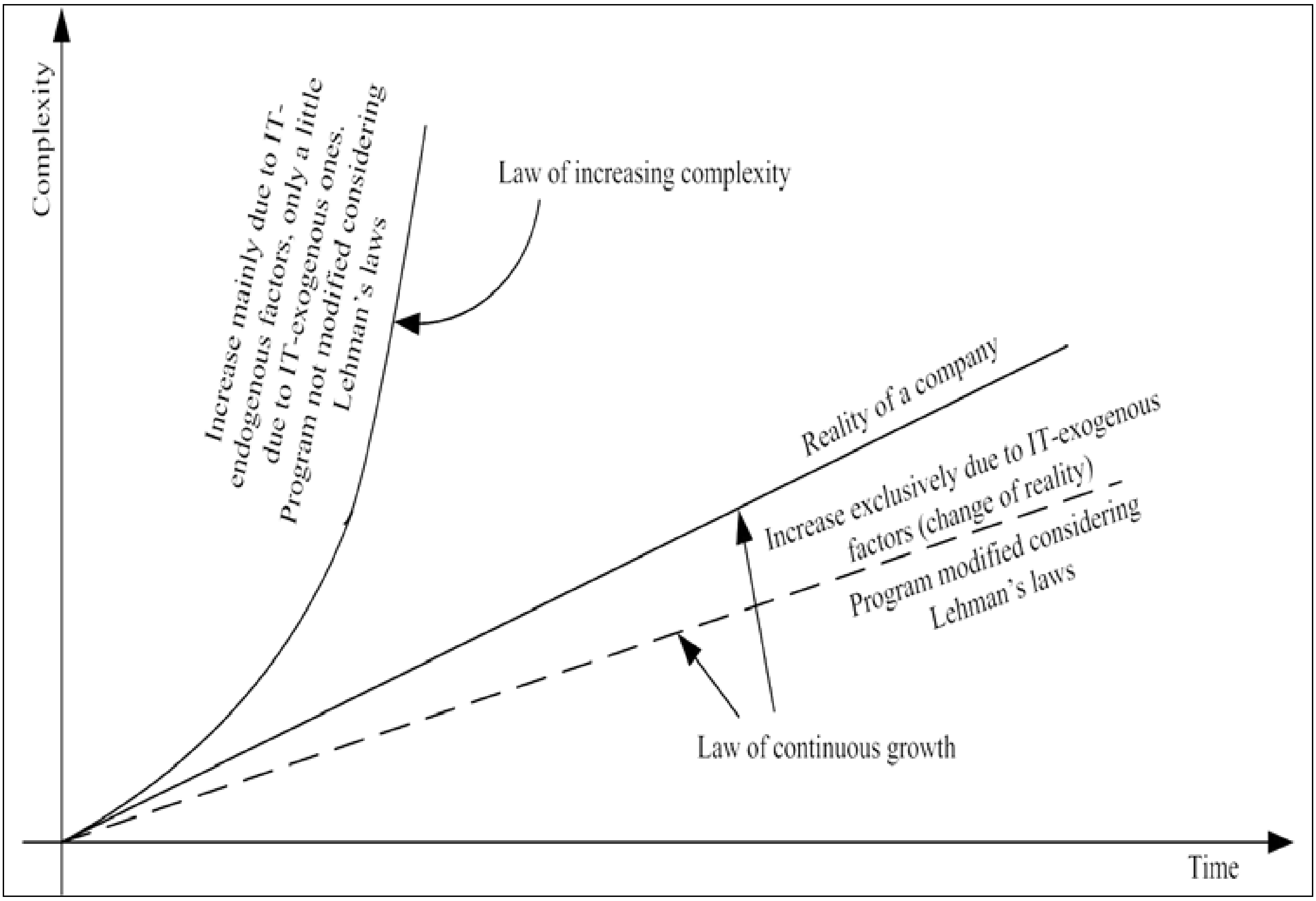
Cycles of knowledge gain
(Holl / Paetzold / Breun, IS anti-aging, 2008)



Embedded mayeutic cycle in IS research
(adapted from
Hevner / March / Park / Ram, Design science, 2004, 80)



Lehmann's E-type system / program
(Kaiser / Reminger, [seminar paper,] 2006)



Increasing complexity of E-type systems
(Holl / Paetzold / Breun, IS anti-aging, 2008)

12 Research methods

Main methods (91%)

Deductive by reasoning (using natural language)
Case study (including ethnography)
Prototyping
Quantitative-empiric
Conceptional-deductive (in semi-formal models)
Formal-deductive (in mathematical model)

Side methods (9%)

Reference modeling
Qualitative-empiric (including grounded theory)
Lab / field experiment
Simulation
Action research

Differences between Information Systems Research and German Wirtschaftsinformatik

Wilde, Thomas; Hess, Thomas:
Forschungsmethoden der Wirtschaftsinformatik.
Eine empirische Untersuchung.
Wirtschaftsinformatik 49(2007) 280-287

13 Guidelines for a method report

The focus of
a method report in an information systems master's program are **scientific methods** **relevant in the field of information systems.**

What is the **purpose** **of scientific methods?**
Scientific methods (techniques) are used
in order to find answers and solutions (goal)
to scientific issues / questions / problems (starting point).

There are different possibilities
to choose a subject for a method report:

1 In the framework of an information systems master's thesis:
describe the scientific issues and the methods
you use to arrive at answers and solutions.

2 Describe a scientific issue relevant for information systems and methods to answer / solve it.

3 Describe a scientific discipline / approach / theory relevant for information systems, its issues and the methods it uses.

4 Describe a scientific method relevant for information systems and possible scientific issues where it can be used.

Important:
Mention type of your report and describe the structure of your report in the introduction.
Give a clear definition of the scientific issue you consider.
Use simple vocabulary and simple syntax in English.
Read my guidelines for theses on my homepage carefully.

<u>References to my own publications</u>

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

Holl, Alfred:
<u>Empirische Wirtschaftsinformatik und evolutionäre Erkenntnistheorie [Information systems as an empirical science and evolutionary epistemology]</u>.
In: Becker, Jörg et al. (ed.): *Wirtschaftsinformatik und Wissenschaftstheorie. Bestandsaufnahme und Perspektiven*.
Wiesbaden: Gabler 1999, 163-207, ISBN 3-409-12002-5.
<u>English translation</u> on my homepage.

Holl, Alfred; Paetzold, Felix; Breun, Robert:
***The role of cooperative cyclic knowledge gain in IS anti-aging*.**
[= Rapporter från Växjö Universitet (Matematik, naturvetenskap och teknik) 2008, *]. Växjo: Växjö University Press 2008. Forthcoming**

Holl, Alfred; Maydt, Dominique:
<u>Epistemological foundations of requirements engineering</u>.
In: Erkollar, Alptekin (ed.): *Enterprise and business management. A handbook for educators, consulters and practitioners*.
Marburg: Tectum 2007, 31-58, ISBN 978-3-8288-9282-8
[extended congress paper for *<u>Requirements Days</u>, Nuremberg, Germany, May 2006*]

Holl, Alfred; Feistner, Edith:
***Mono-perspective views of multi-perspectivity: IS modeling and 'The blind men and the elephant'*.**
Växjö: Växjö University Press 2006 [= Acta Wexionensia 87/2006 (Information Systems)];
short version = contribution to:
***Information Systems Research in Scandinavia (IRIS'27)*, Falkenberg/Sweden 2004, CD-ROM.**

Holl, Alfred; Valentin, Gregor:
Structured business process modeling.
Contribution to:
***Information Systems Research in Scandinavia (IRIS'27)*, Falkenberg/Sweden 2004, CD-ROM.**

Holl, Alfred; Auerochs, Robert:
Analogisches Denken als Erkenntnisstrategie zur Modellbildung in der Wirtschaftsinformatik [Analogical thinking as a cognitive strategy for model design in information systems].
In: Frank, Ulrich (ed.): *Wissenschaftstheorie in Ökonomie und Wirtschaftsinformatik. Theoriebildung und –bewertung, Ontologien, Wissenmanagement.*
Wiesbaden: DUV 2004, 367-389, ISBN 3-8244-0738-8.

Holl, Alfred; Krach, Thomas:
Ubiquitäre IT – ubiquitärer naiver Realismus [Ubiquitous IT – ubiquitous naive realism].
In: Britzelmaier, Bernd et al. (ed.): *Der Mensch im Netz. Ubiquitous Computing. - 4. Liechtensteinisches Wirtschaftsinformatik-Symposium an der FH Liechtenstein*.
Stuttgart: Teubner 2002, 53-69, ISBN 3-519-00375-9.

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