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Problem analysis: the analytical phase in a phase concept of IS development (SW process)

1 Motivation: phase concept / software process (precise examination)

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 (require-ments engineering)
	design of the business concept of the technical IS (KEY)		
synthetical phase: IT system development	design of the technical concept of the technical IS	implementa-tion-relevant models	
	programming		
	test		
	use	information-relevant models	
maintenance			

2 Preliminary examination (strategic phase) 1

2.1 Principles 1

Objectives:
- to figure out goal and purpose of the project
- to design a coarse business concept (Grobkonzept)
- to examine the feasibility (Durchführbarkeitsstudie)
- to finally decide about project initiation (Projektanstoß)

Coarse business concept: What is the problem / application area?
system definition: remember that
organizations are open socio-technical information systems!

1. System delimitation, system boundaries,
external coupling to the system surroundings
(Umweltkopplung zur Systemumgebung):
- Remember: magnifying glass (geographic lens):
model boundaries wider than direct IT application area
- Attention: cognitive processes during segmentation
- Attention: arbitrary object boundaries.
Where is the rim of an organization?
→ 2.2 Problem of isolation / separability

2. Components, interactions, internal linkage (Binnenkopplung),
partial systems on the next lower abstraction level

3. Goal and purpose of the system definition
Which purpose shall modeling during the precise examination meet? Which aim shall it reach?
Which question shall it answer?
E.g. preparation of the deployment of individual SW,
selection of standard SW,
planning of business process reengineering

2 Preliminary examination (before SW process) 2

2.1 Principles 2

4. Feasibility

4.1 mathematical-formal accessibility to modeling
(important to estimate the duration of the project)
- pre-formalization (Vorformalisierung)
- accessibility to formalization (Formalisierbarkeit)
- effort of formalization (Formalisierungsaufwand)

→ 2.3 Problem of pre-formalization

4.2 technical (IT) feasibility
- coordination with existing IT systems
- individual SW, branch SW, standard SW

4.3 financial und temporal feasibility
- human and technical resources (Personal- und Sachmittel)
- possibility of financing, e.g. credits (Finanzierbarkeit)
- cost estimation (Aufwandsschätzung):
time, development costs, resulting costs (Folgekosten)

4.4 human resources psychology (Arbeitspsychologie)
- acceptance: hindered end-users (verhinderte Endbenutzer)
- resistance: forced end-users (gezwungene Endbenutzer)
- fear of rationalization (Rationalisierungsangst)

4.5 juridical and ethic feasibility
- technology assessment (Technikfolgenabschätzung)
- social acceptability/responsibility (Sozialverträglichkeit)
- data privacy (Datenschutz)

2.2 Problem of isolation / separability 1

Observations

trouble with not effective, isolated SW solutions
trouble with the limitation of systems

Critical realism

1. complexity reduction by creating segments and structures
2. there are natural system-like structures
with strong internal and weak external connections
but: there aren't any natural closed systems,
only open systems [socio-technical information systems in IS]
==> systems: descriptive categories, not reality-immanent
it is the observer who defines system boundaries

There is no empirical knowledge without isolation of systems!
(2nd epistemological dilemma)
Isolation is the pre-condition for
– the mere cognition of objects
– the transfer of feature sets, the perception of "gestalts"
– the comparison of objects
(Lorenz "The innate forms of possible experience" 1943: 319)

Evolutionary epistemology

1. cerebral cortex as carrier of cognitive processes
has its origin in optical neural centers;
consequence: cognitive strategies are transferred from
primary objects of cognition
visual-tangible (physical solids), simple,
few interactions, 'mesocosmic'
to secondary objects of cognition
socio-economical, sub-atomic particles, complex,
numerous interactions, macro/microcosmical
2. small segments are better suitable as basis of analogy

2.2 Problem of isolation / separability 2

Consequences for IS

**1. at least: SA context diagram or UML use case diagram
with system surroundings and external connections**
**2. better: magnifying glass model:
soft, blending system boundary
with precision/magnification decreasing towards the rim**
3. clear idea of the system's purpose and objectives

Remark 1 (ambiguity of segmentation)
There are different ways of decomposing an object domain.

Example: magnet: optical field vs. magnetic field

Remark 2 (abstraction levels)
Humans cannot understand complex systems at first glance
**==> complexity reduction by decomposition
is necessary on different abstraction levels**
==> problem of isolation occurs on every abstraction level

Remark 3 (process – system)
**Processes can be interpreted as (linear) systems,
therefore, there are equivalences**
– open process ~ open system
– process boundary ~ system boundary (defined by observer)
– process decomposition ~ system decomposition (→ IV.3.1.2)

2.2 Problem of isolation / separability 3

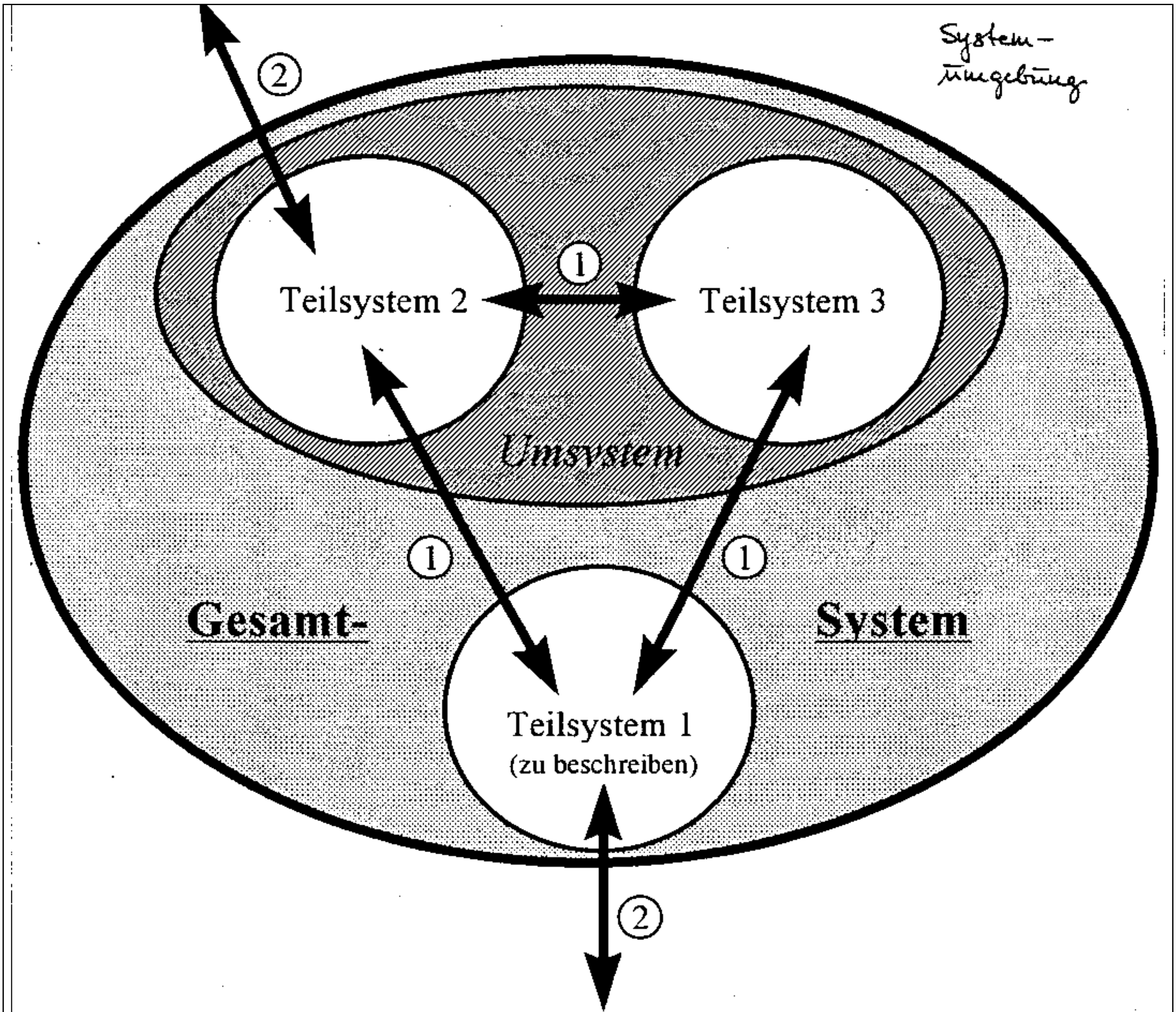
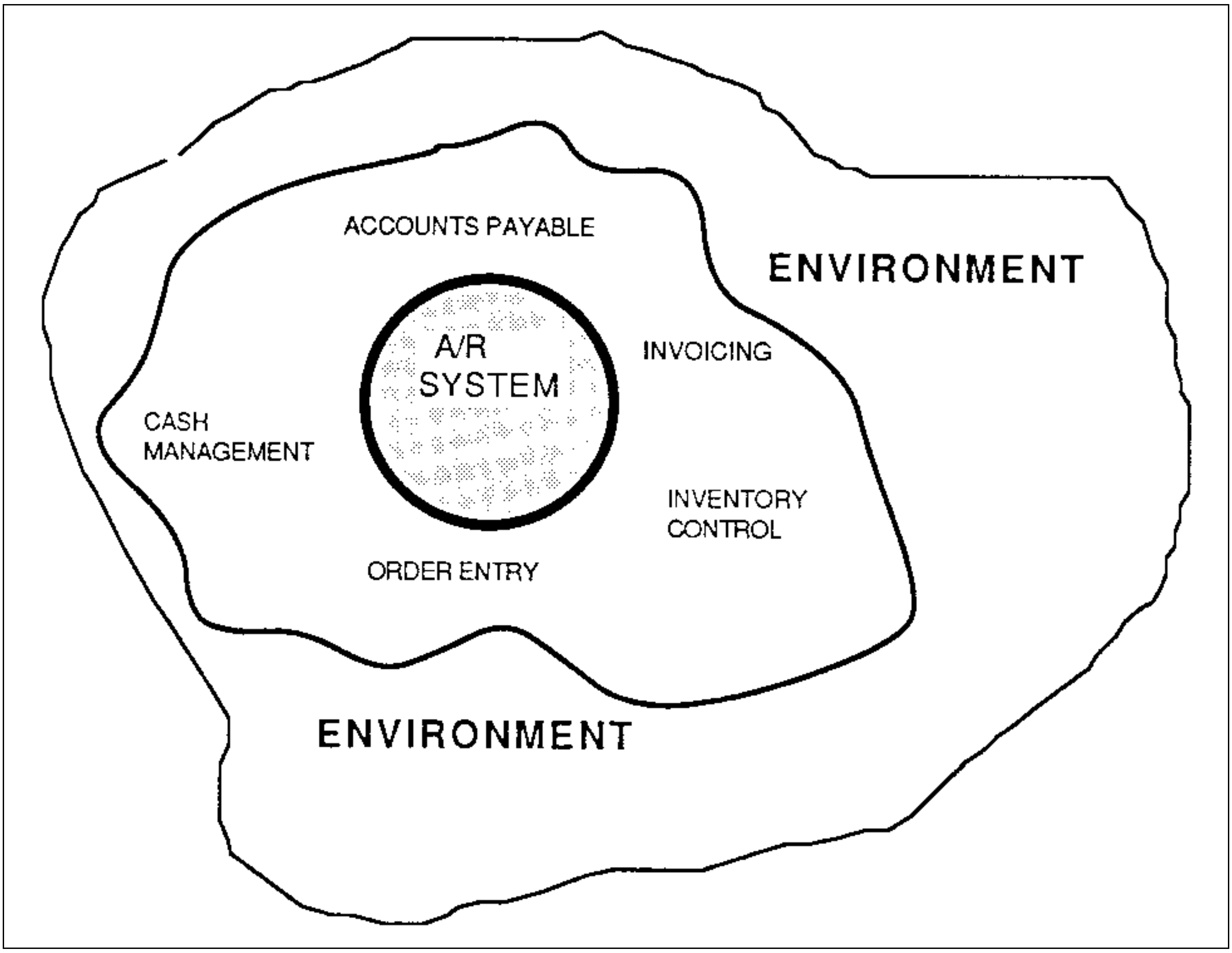


Abb. 12: Abbildung eines komplexen Systems mit seinen Teilsystemen und Schnittstellen

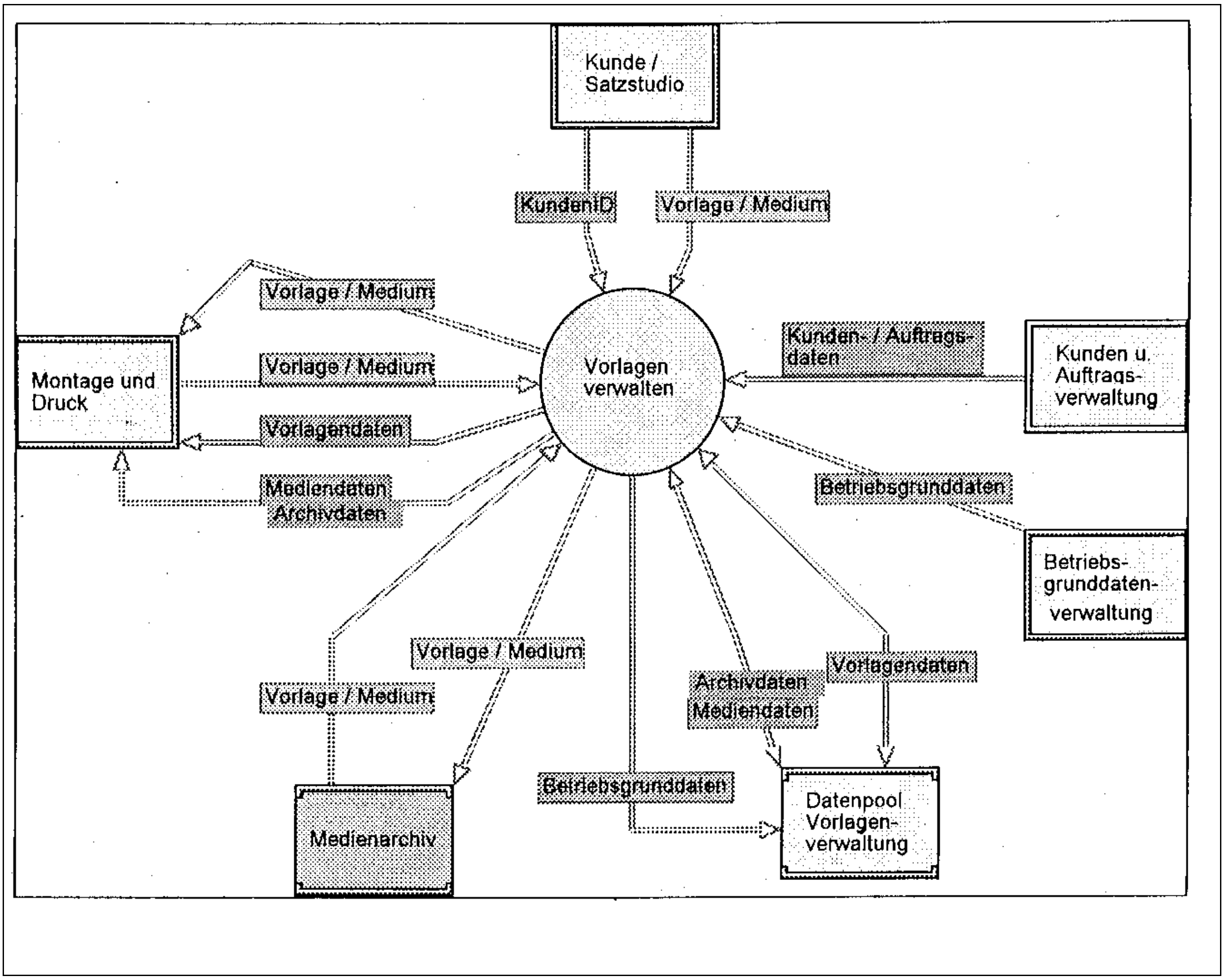
Surrounding system and system surroundings
(from a diploma thesis)

2.2 Problem of isolation / separability 4



Accounts receivable system embedded in the enterprise (Yourdon, Modern structured analysis, 1989, 336)

2.2 Problem of isolation / separability 5



System surroundings in a structured analysis context diagram (from a diploma thesis)

2.2 Problem of isolation / separability 6

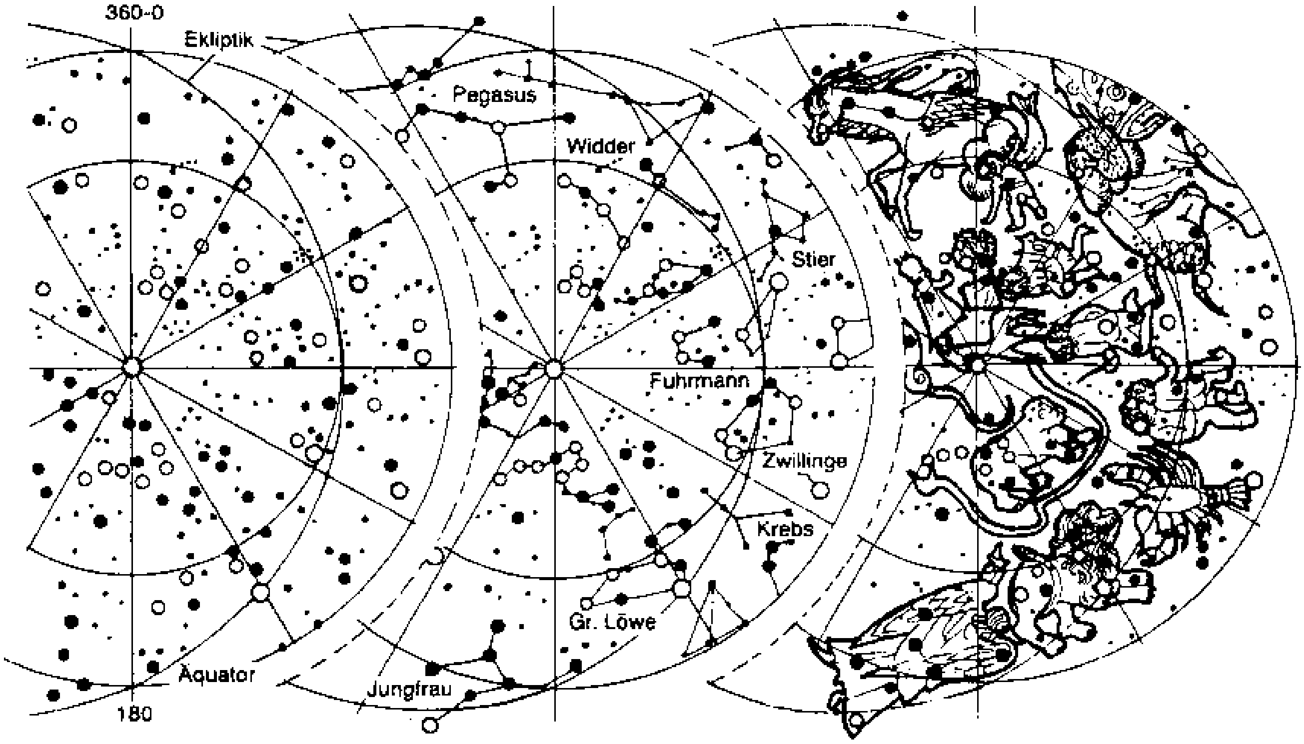


Abb. 6. Gestalt, wo keine ist, am Beispiel eines Ausschnittes des nördlichen Sternenhimmels. Man beachte links die reale Zufallsverteilung der Sterne und ihrer Größen, in der Mitte deren Verbindung zu Sternbildern, rechts die barocke Darstellung nach dem Himmelsatlas von Andreas Cellarius, der 1708 in Amsterdam erschien. Sie ist um 90° C gedreht und um die Achse 90–270° C gewendet, um der heute üblichen Orientierung zu entsprechen (vgl. Störig 1972).

Constellations: form, where none exists,
exemplified by a section of the northern celestial sky;
to the right, the baroque representations by Cellarius 1708
(Riedl, Biology of knowledge, 1984, 157)

2.2 Problem of isolation / separability 7

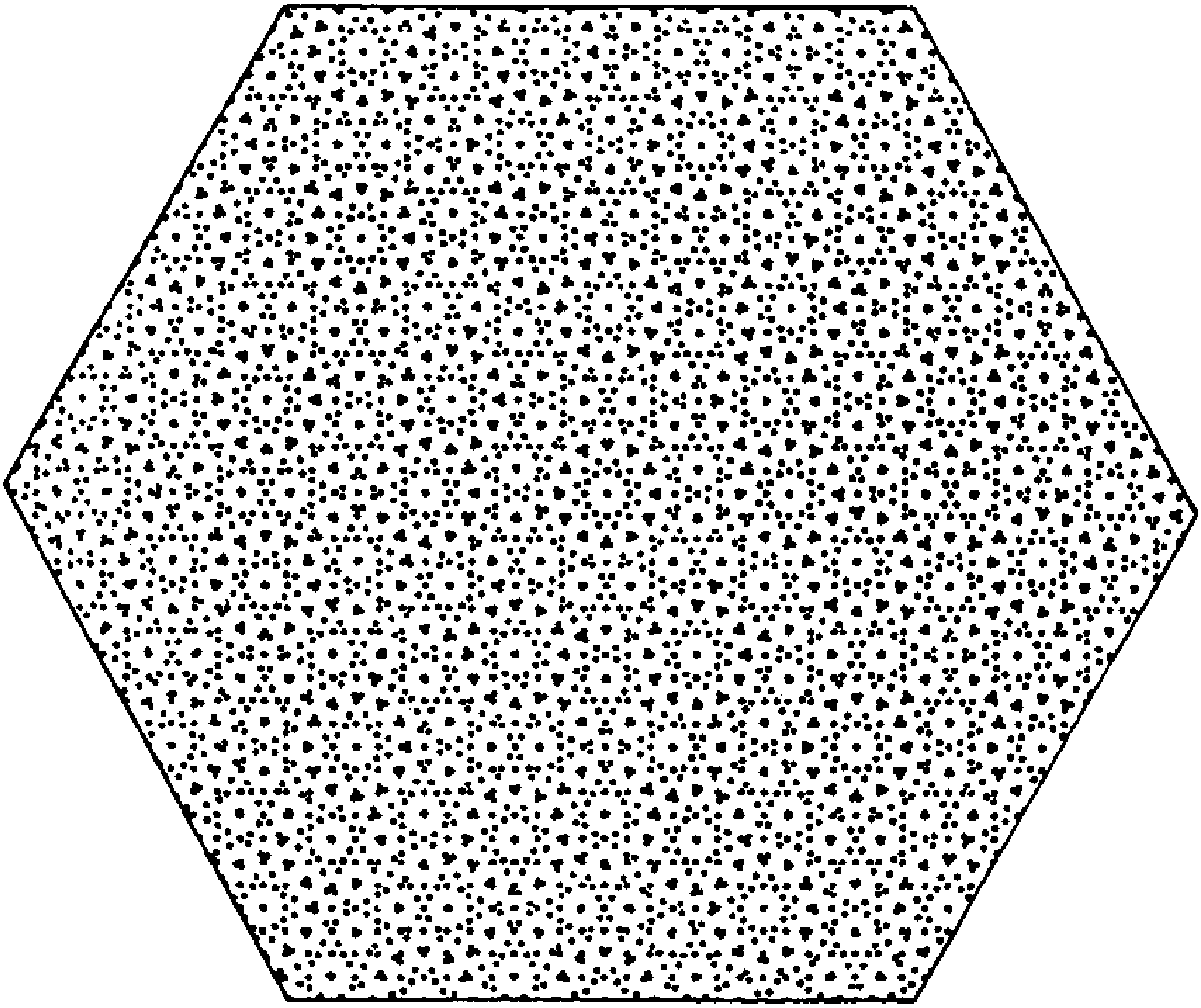


Abb. 2.30: Illustration des autonomen Strukturierungsprozesses unserer visuellen Wahrnehmung. Wir nehmen einen raschen Wechsel verschiedener Muster wahr. Unsere Wahrnehmung sucht nach Ordnung. Sie strukturiert das Wahrgenommene und interpretiert es auf verschiedene Weise. Aus D. MARR (1982).

Construction of structures by visual perception
(Eibl-Eibesfeldt, Biologie des menschlichen Verhaltens, 1995, 77)

2.3 Problem of pre-formalization, suitability for and effort of formalization

Observations

It is more difficult to model small organizations than large ones.
SW development for accounting is easier than for production.
Suitable descriptive categories
are often unknown in organizations
and model designers have to start from scratch to define them.
It is difficult to estimate the time necessary for formal modeling.

Critical realism

With regard to formalization, IS object domains differ in:

- **pre-formalization**
- **suitability for formalization**
  (cf. deterministic vs. (non-) deterministic, chaotic domains)
- **effort of formalization**

→ not pre-formalized, scarcely formalizable object domains
→ partly pre-formalized object domains: implicit formal models
→ well pre-formalized object domains: explicit formal models

Consequences for IS

Examine object domains with respect to 3 views of formalization.
Respect the results in time and project management.
Pre-formalized domains are starting points for IT (accounting).
Don't force formalization, allow chaotic oscillations (production).
Check terminology used in organizations
with regard to suitability for formalization.

Remark (structuring)

These considerations apply
for pre-structures, suitability and effort for structuring as well.

3 Precise examination of the application area 1 (phase concept / software process)

3.1 Principles 1

1. Elicitation of the current state (Ist-Aufnahme):
description of the lock

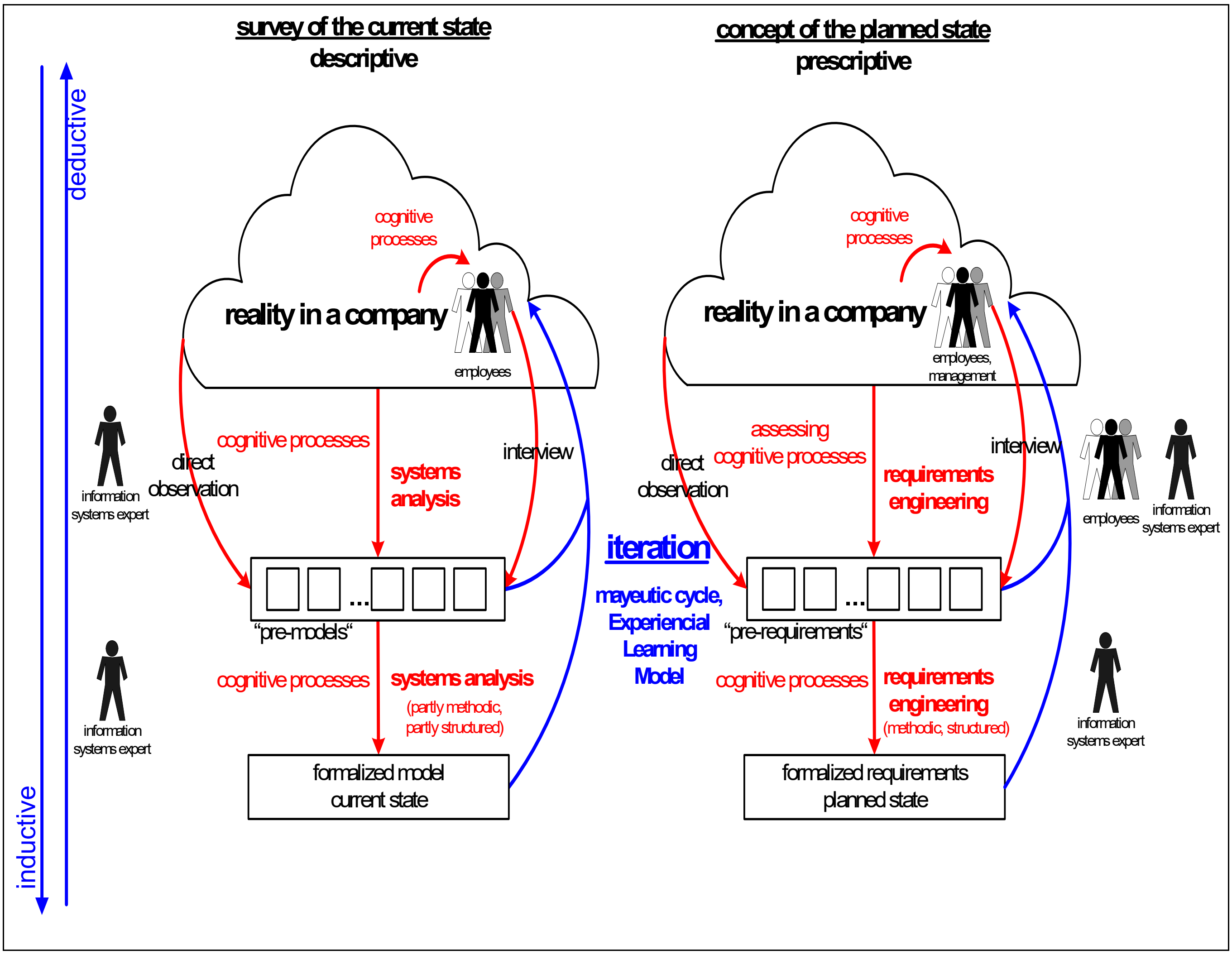
2. Analysis of the current state (Ist-Analyse):
Is the lock straight (pre-formalized), crooked,
can it be straightened?
Analysis of defects (Schwachstellenanalyse):
where are changes necessary?
Requirements Engineering (continued in step 3)
Proposals for solutions (Lösungsalternativen):
how should changes be made?

3. Concept of the planned state (Soll-Konzept):
formal model of the lock (organization)
formal model of the key (technical information system)
fine business concept (fachliches Feinkonzept, Pflichtenheft)

→ part 9: meta-models and notations of modeling approaches

3 Precise examination of the application area 2

3.1 Principles 2



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

3 Precise examination of the application area 3

3.2 Requirements engineering: requirements in natural language

Rupp, Chris: Requirements Engineering. München 2001
based on R. Bandler/J. Grinder: Neuro-linguistic programming

This psychiatric approach tries to find the underlying meaning of utterances produced by means of transformations
(cf. Freud's projection to others and exaggerated contrary)

Deletion

implicit assumptions
incomplete properties:
easily changeable: **how easily? what's easy? by whom?**
incomplete verbal nuclei/kernels
(missing objects and adverbials; cf. dependence grammar):
SW shall inform about errors: **whom? where? how? when?**
the development of a SW tool: **who develops? when? why?**

Generalization

universal quantors:
every error: **really every? any exceptions?**
incomplete conditions:
If the error X occurs in the last phase of program Y, then ...
What should be done if it occurs in another phase?
definite article without text reference:
the error: **which?**

Distortion

nominalization: resulting event instead of process
loss of data: **which data are lost? when? how? why?**

3.3 Requirements changes during problem analysis: temporal dynamics of the application area 1

Observations

SW does not meet requirements after long programming periods.

Critical realism

Every segment of the reality contains internal temporal dynamics, which can partly be deterministic and partly chaotic.
Prognoses of its future behavior are only partly reliable, especially if a segment is disturbed.

Consequences for IS

in general:

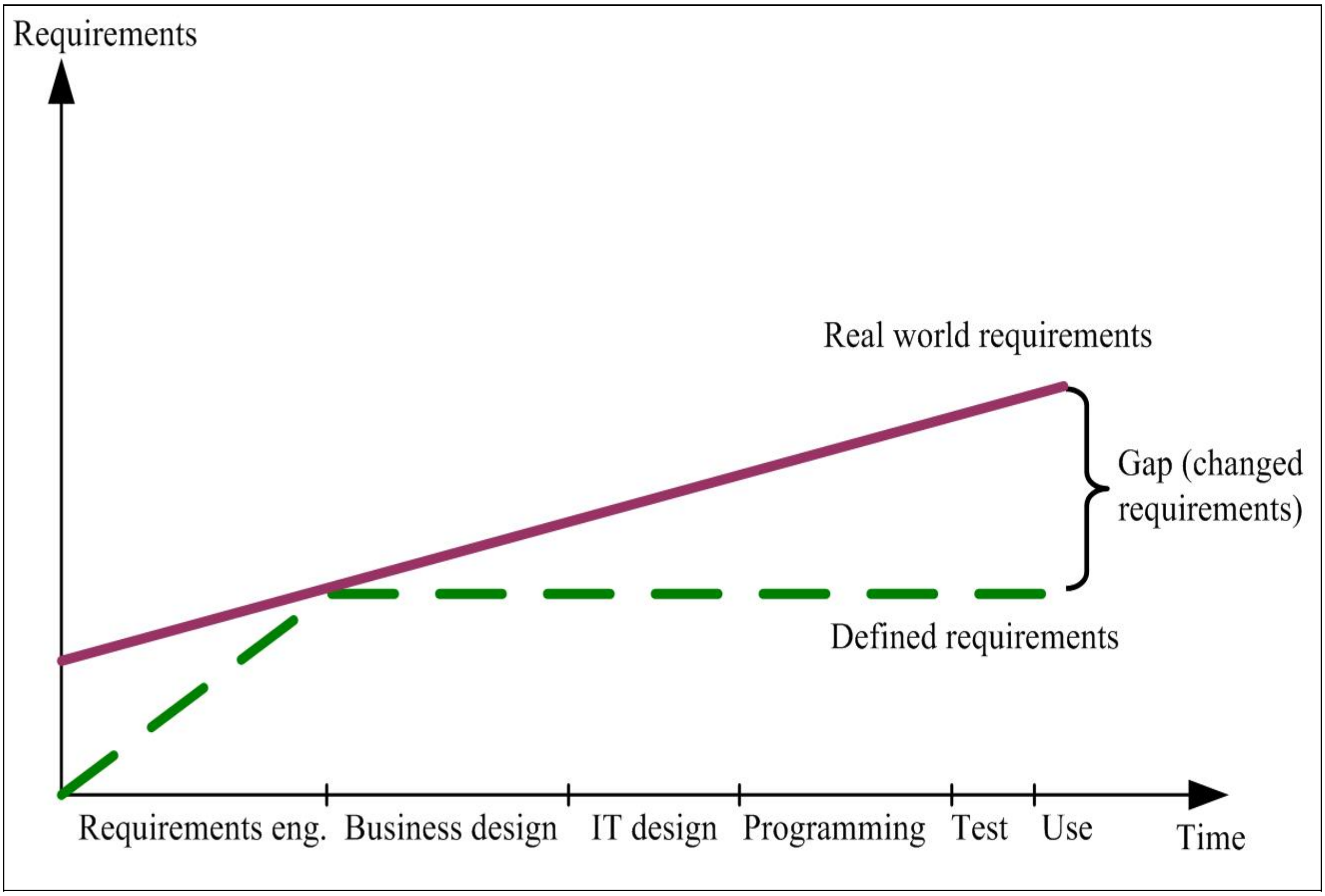
1. keep your model of the planned state valid
by quickly including changes in the application field in order to avoid using models of a past reality for programming
2. keep your models and your SW easily changeable in order to be able to easily change models and SW
in the case of changes in the application field

Consequences for IS

in detail:

an aspect of changed / creeping requirements management
overlapping phases and iterations in phase concepts
dynamic design concepts
permanent check of changes in the application field
permanent contact to the future users
participative strategies
evolutionary SW development
well-documented and easily adaptable SW
some aspects of 'extreme programming'
(user participation, quick development, small projects)

3.3 Requirements changes during problem analysis: temporal dynamics of the application area 2



Changed / creeping requirements gap
(Holl / Paetzold / Breun: IS anti-aging, 2011, fig. 17, p. 39)

4 Software evolution – IS anti-aging 1

Changes in reality require changes in software:

changed / creeping requirements management (cf. 3.3)

1st: introduction of changes in an IT independent (business) model

2nd: design of a new IT (dependent) model based on two sources:

1 the new IT independent model (information-relevant level)
2 the old IT (dependent) model (implementation-relevant level)

If the IT independent (business) model level is ignored and the new IT model is based only on the old IT model, SW complexity will soon increase a lot faster than the complexity of the underlying reality.

Reason: SW complexity has two sources:
- **complexity of the underlying reality**
- **IT-immanent (IT dependent) complexity**
  due to performance optimization, features of IT products etc.

Long-term SW evolution restricted to the IT level is impossible!

Include possible future changes in reality you can already foresee always in the IT independent (business) model level!

cf. Meir Lehman: E (embedded) type programs

requirements engineering on the basis of epistemology

4 Software evolution – IS anti-aging 2

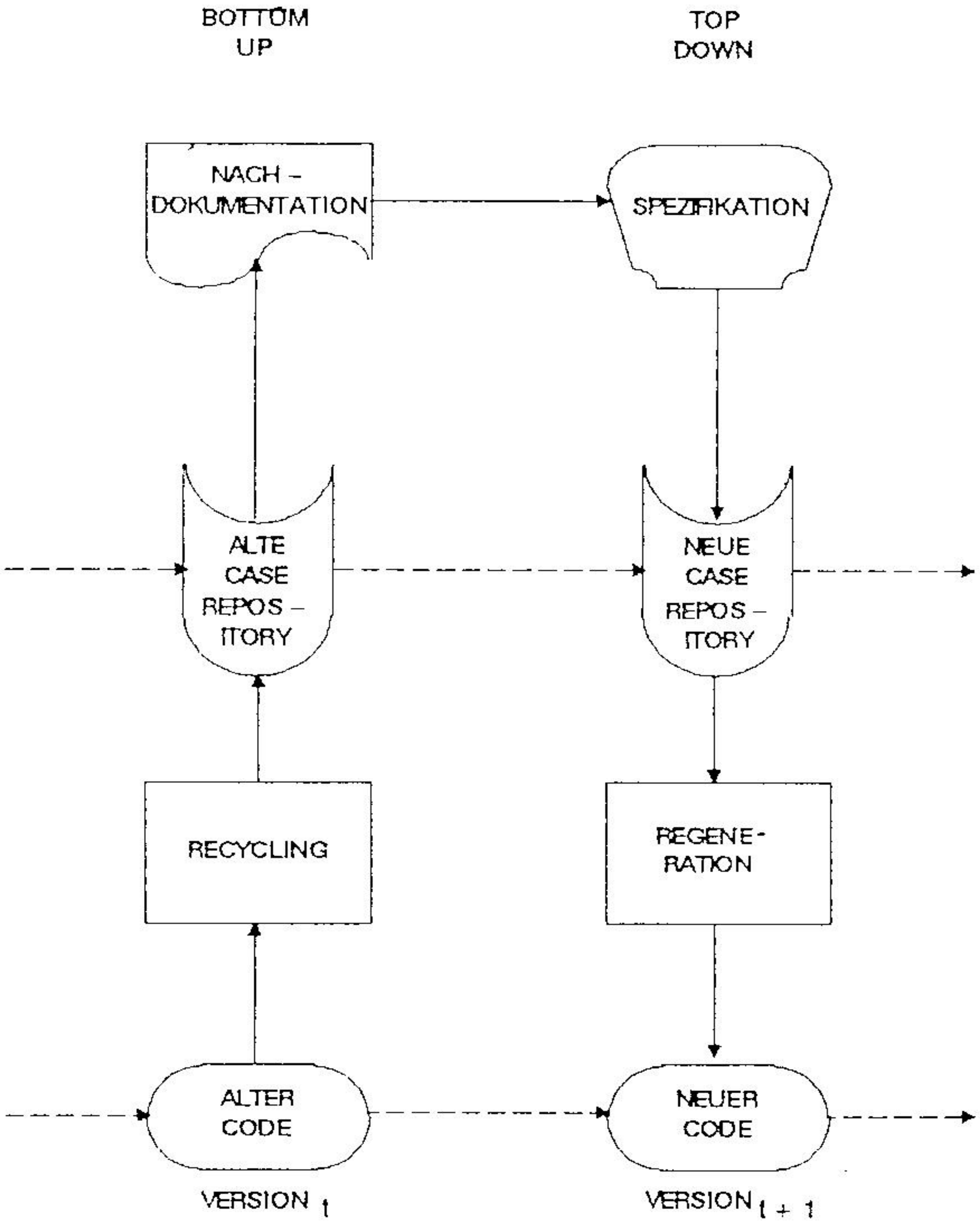
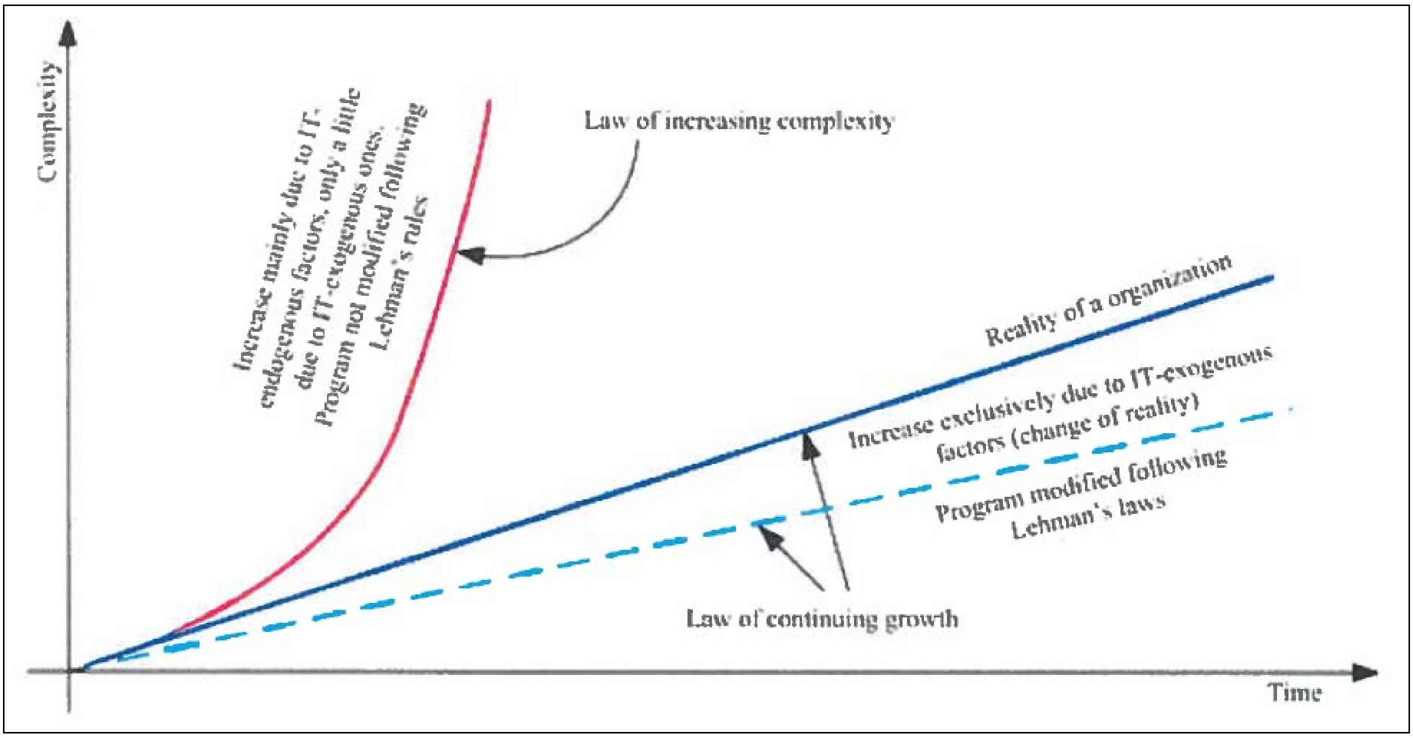


Abb. 2.10: Bottom-Up Software-Entwicklung

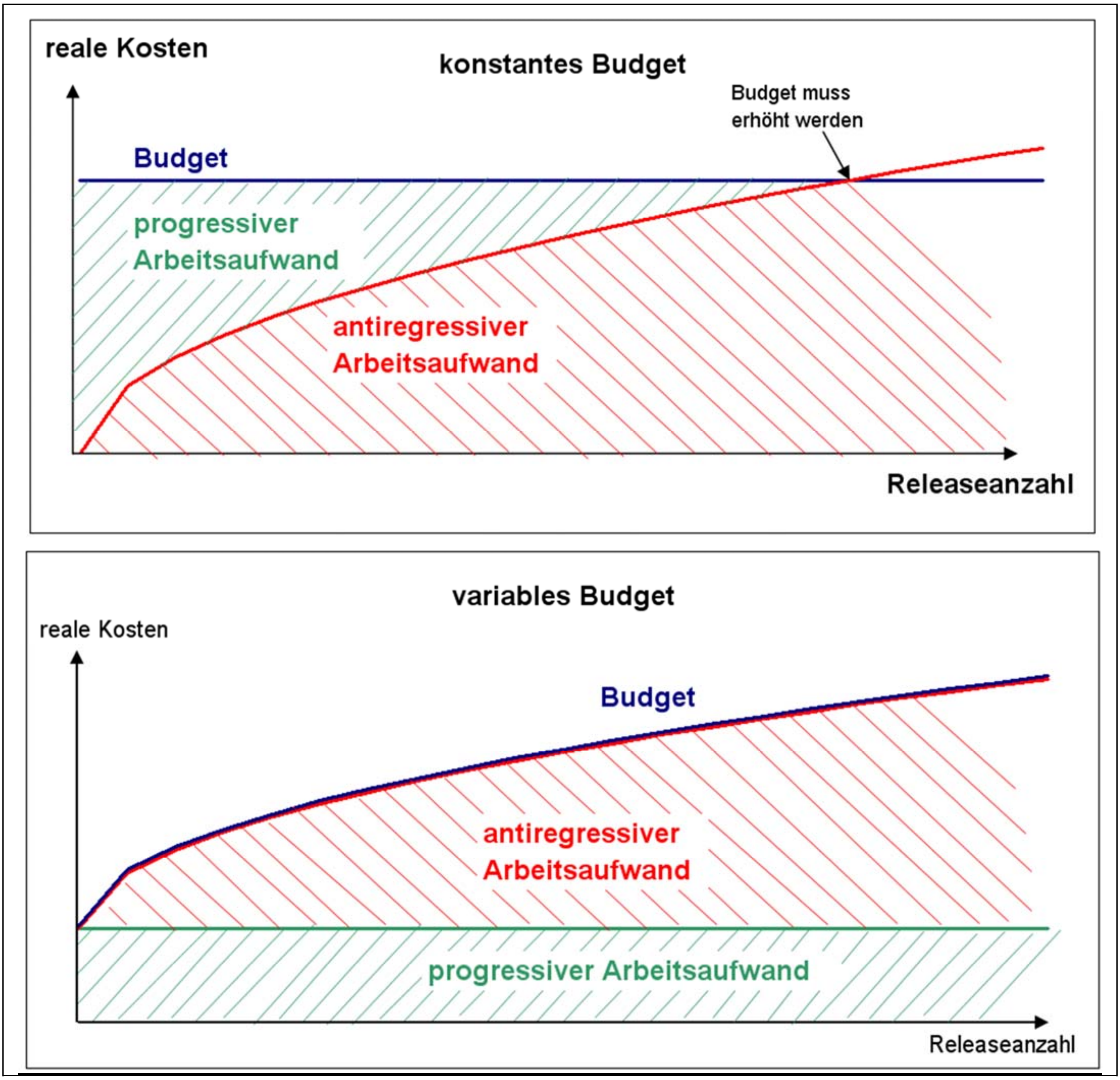
Bottom-up software development
(Sneed, Harry M.: Software maintenance, 1991, fig. 2.10)

4 Software evolution – IS anti-aging 3



Increasing complexity of E-type systems
(Holl / Paetzold / Breun: IS anti-aging, 2011, fig. 20, p. 44)

4 Software evolution – IS anti-aging 4



Progressive and anti-regressive costs over time

5 References

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

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