Immanuel Kant Baltic federal university

Lecture at the Institute of Philosophy, Kaliningrad, 19.10.2012
http://philoslog.gorodkanta.ru

Kant's Architecture of Mind

A Cybernetic Approach to
„*the hitherto rarely attempted dissection of the faculty of the understanding*“ (B 90)

Marco Bettoni
www.weknow.ch

Agenda

1. Looking back in time … 1985 - 2000
2. Kant’s famous example B 137/138
3. Introduction, Functional Structure
4. The Critique of Pure Reason: An Architecture of Mind
5. Otfried Höffe‘s short comment 2003
6. Method of Substitution & Cybernetic Approach
7. System Model, Publications, CpR main parts
8. Broad Architecture of Mind
9. Architecture of SINNLICHKEIT and VERSTAND
10. System Dynamics: Examples
11. Conclusions

… help neuroscience in the mind-system identification task …

Marco C. Bettoni

"**A Psychological Basis for Human Information Processing**: Mental Operations between Receptors and Effectors in the Approach of Silvio Ceccato".

Research Report
120 pages,
Institute for Methods and Structures,
Zürich/Basel,
Mai 1985

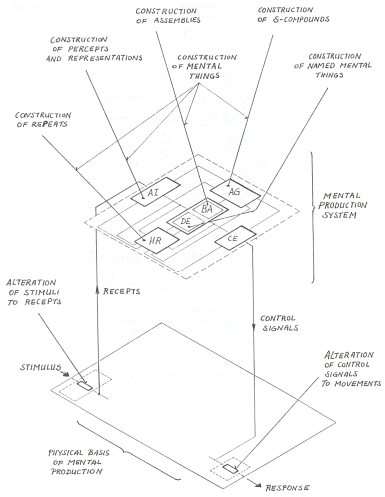


Fig. 13 Names for the results of the mental activities (level A).

3

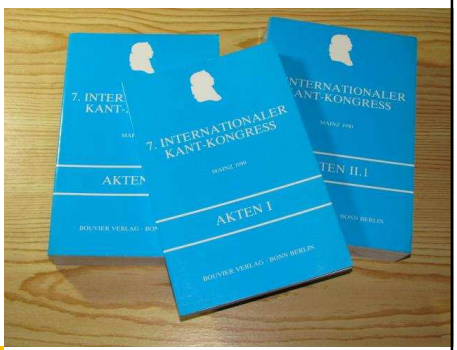
VII. Internationaler Kant-Kongress
Universität Mainz, 1990

Sektion Künstliche Intelligenz

Cybernetics Applied to Kant's Architecture of Mind

A System Model and its implications for Knowledge Representation in the Brain and in the Computer

Marco Bettoni
29.3.1990



Special thanks to
Prof. Dr. Thomas M. Seebohm

http://www.weknow.ch/marco/A1991/Bonn/Bettoni_1990_KAM_ext.pdf

4

VI. Kant-Tagung – Svetlogorsk 1993
Russische Kant-Gesellschaft

Sektion 4: Logische Kantforschung

Kants 'Kritische Teleologie'
und ihre Anwendung
in der Künstlichen Intelligenz
Teil 1

Marco Bettoni
22.9.1993

M. Bettoni, 19.10. 2012 5

IX. Internat. Kant-Kongress,
Humboldt Universität, Berlin, 2000

Section 18 - Kant und die Folgen

Learning from Kant
How To Construct
Robots
Suggestions for
an Engineering Approach to the
Analytic of Concepts

Marco Bettoni
26.3.2000

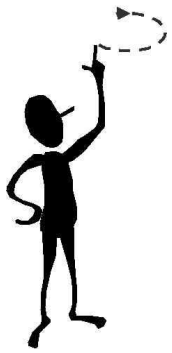
http://www.weknow.ch/aqm/berlin2000/Talk000326.html

6

Kant's Famous Example & Rudisill's Pantomimics

CpR B 137/138 & Kant-Studien 87, 2, 132-148

- To know anything in space (for instance, a line) I must *draw* it, and thus synthetically bring into being a determinate connection of the given manifold, so that the unity of this act is at the same time the unity of consciousness.
- Um aber irgend etwas im Raume zu erkennen, z.B. eine Linie, muß ich sie *ziehen*, und also eine bestimmte Verbindung des gegebenen Mannigfaltigen synthetisch zu Stande bringen, so, daß die Einheit dieser Handlung zugleich die Einheit des Bewußtseins (im Begriffe einer Linie) ist.



Idea for the picture from:

- Rudisill, Philip McPherson (1996), *Circles in the Air. Pantomimics and the Transcendental Object = X*. Kant-Studien. Band 87, Heft 2, Seiten 132–148.

M. Bettoni, 19.10. 2012 7

Introduction

- My education & work: engineering, management
- But research interest: *abstract concepts* (cognition)
- Faculty of operating with abstract concepts:
  - In the mind
  - In the machine
- Realize in the machine the mechanisms of the mind
- Functional approach to cognition:
  - Study mental functions independently from their biological basis
- Applications:
  - Analyse the biological implementation
  - Design an artificial implementation

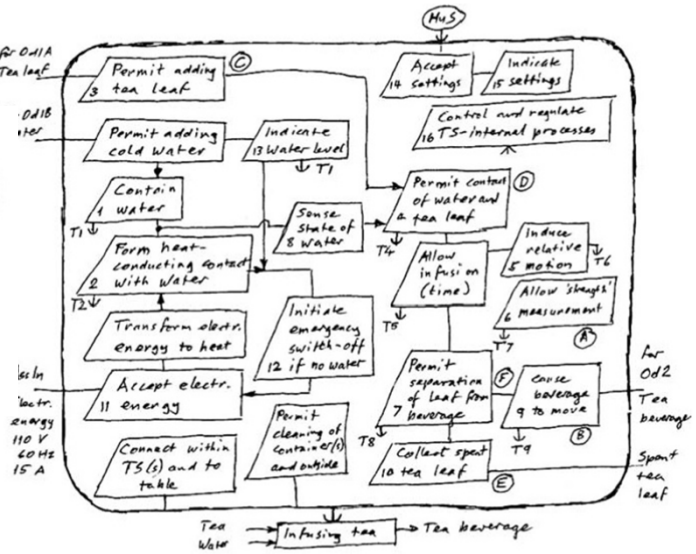
8

Functional Structure

- Neueropsychology - Aleksandr R. Luria (1976, 1980)
  - The analysis of the cerebral basis of any mental process must be preceded by an analysis of its «functional structure»
- Machine design theory - Vladimir Hubka (1982)
  - The design of an artificial system must be preceded by the development of its “functional structure”
- Computer science – Wolfgang K. Giloi (1981)
  - information structure + control structure = functional structure of a software system

M. Bettoni, 19.10. 2012 9

Functional structure of a tea machine V. Hubka, 1983



M. Bettoni, 19.10. 2012 10

The Critique of Pure Reason: An Architecture of Mind?

- Functional structure ⇔ *architecture*
- Abstract concepts ⇔ *pure concepts of reason*
- *«The architectonic of pure reason» - B860*
- *Letter to Markus Herz, 24. Nov. 1776*

➢ *Read as a description of an architecture of the mind*

M. Bettoni, 19.10. 2012 11

Otfried Höffe's short comment

- «*interesting, but wrong in its interpretation of Kant's system concept, is Bettoni's application of cybernetics to Kant's Architectonic"*

[48] Kapitel 22 bildet Höffe (1998) fort. Zu Kants Architektonik und System s. Fulda/Stolzenberg (2001); interessant, aber Kants Systembegriff mißdeutend ist Bettonis (1991) Anwendung der Kybernetik auf Kants Architektonik.

➢ in: Höffe, O. (2003) Kants Kritik der Reinen Vernunft. Die Grundlegung der Modernen Philosophie. München, C. H. Beck. Footnote 48, page 303.

M. Bettoni, 19.10. 2012 12

Method of Substitution

- Approach to the Kantian text: «technical»
- Looking for mechanisms, dynamics
- Aim: model of mental mechanisms
- Method:
  1. Choose a frame, an explicit point of view: cybernetics; obtain relevant terms
  2. Substitute original terms by cybernetic terms in few, selected sentences
  3. Evaluate: viability, inner coherence; if not satisfied: repeat step 1 and 2
  4. Apply the evaluated substitutions in other parts of the text; then repeat step 3.

13

Cybernetics

- “the entire field of control and communication theory, whether in the machine or in the animal.” - Norbert Wiener, 1948
- "The art of creating equilibrium in a world of constraints and possibilities.“ - Ernst von Glasersfeld
- http://www.asc-cybernetics.org/foundations/definitions.htm
- My definition:
  - the science that considers dynamic systems in terms of OPERATIONS & CONTROL and aims at enabling artificial systems to perform like organisms at 3 levels: physical, biological and mental.

M. Bettoni, 19.10. 2012 14

Cybernetic Approach

1. Tecnica Operativa
2. Information Processing System
3. Qualitative Approach
4. New Biology
5. Assimilation & accomodation
6. Viability
7. Autopoiesis & self organization
8. Operators, operations, operands
9. Operational sequences
10. Architecture view + process view = system

M. Bettoni, 19.10. 2012 15

Silvio Ceccato (1914-1997)

- cognitive science pioneer (linguistics, philosophy, cybernetics)
- Criticizes:
  - knowing as „duplication of the percept“
  - consequence: knowing, abstraction, concept, information, representation, point, number, truth, etc. used as „non-reducible metaphors“
  - consequence: scepticism and dogmatism (reality)
- http://www.methodologia.it/

M. Bettoni, 19.10. 2012 16

Silvio Ceccato's Approach

TECNICA OPERATIVA (1947, Entretiens de Zürich)

- *„consider any mental content (percepts, images, concepts, thoughts, words, etc.) as a result of operations"*

CONSAPEVOLEZZA OPERATIVA

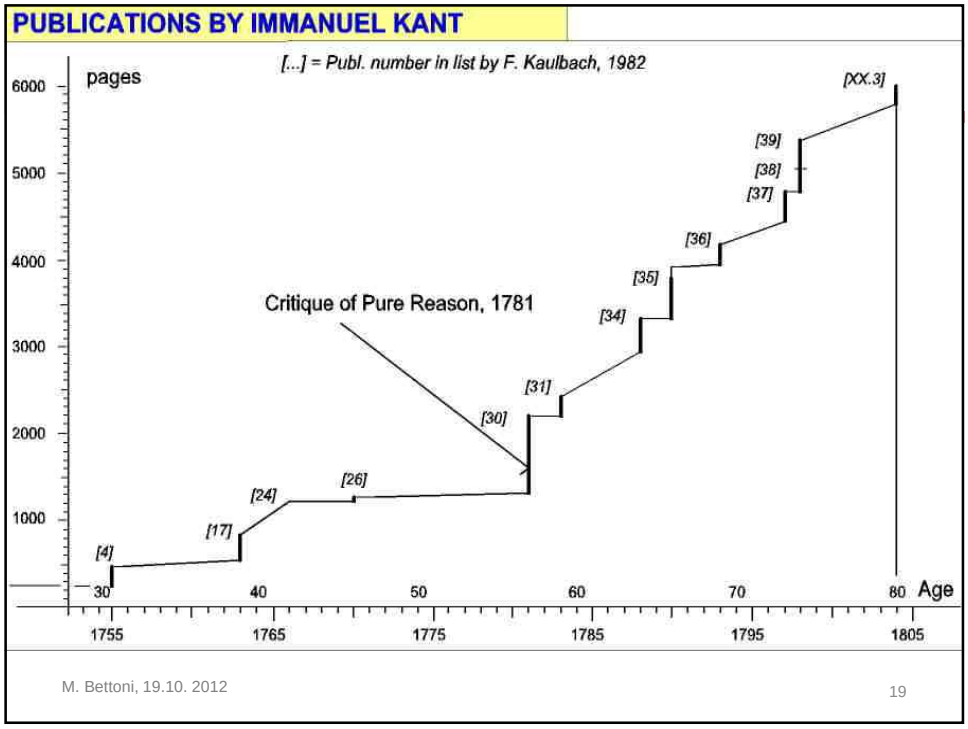
- *„which mental operations do we perform in order to conceive a situation in the way we conceive it ?"*

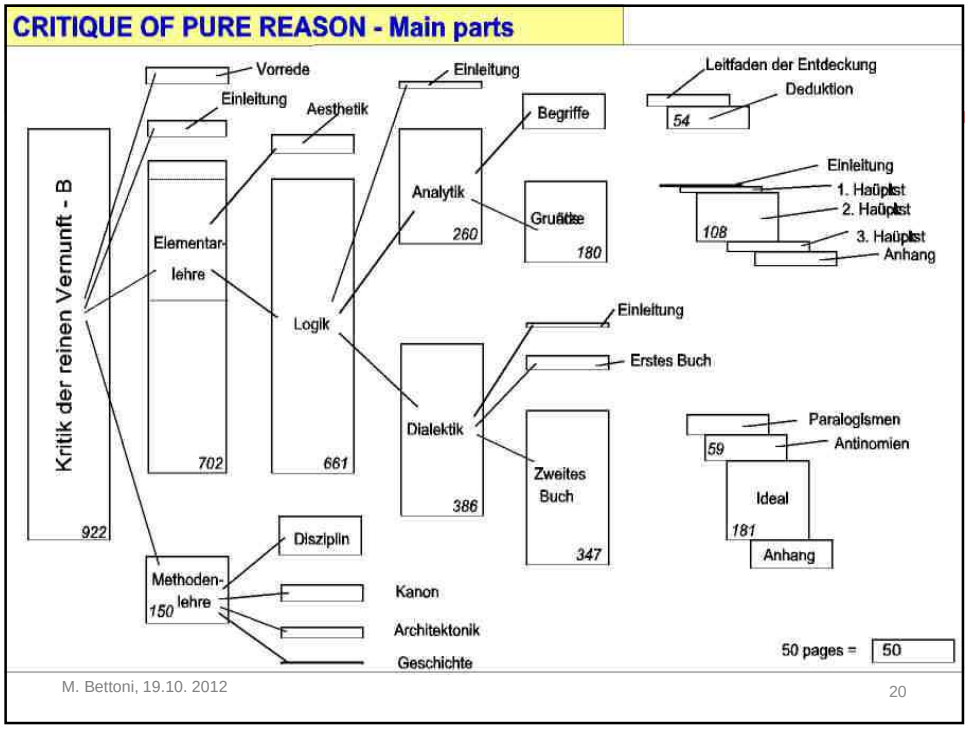
M. Bettoni, 19.10. 2012 17

System Model

- First, rough prototype
- Qualitative
- Text used:
  - Critique of Pure Reason, 1787
- Sections:
  - Transcendental Aesthetic (B33 – B73)
  - Transcendental Analytic: Introduction (B74 - B88)
  - Transcendental Analytic: Analytic of Concepts (B90 – B169)

M. Bettoni, 19.10. 2012 18


PUBLICATIONS BY IMMANUEL KANT
[...] = Publ. number in list by F. Kaulbach, 1982
pages
6000
5000
4000
3000
2000
1000
Critique of Pure Reason, 1781
[4]
[17]
[24]
[26]
[30]
[31]
[34]
[35]
[36]
[37]
[38]
[39]
[XX.3]
30
40
50
60
70
80
Age
1755
1765
1775
1785
1795
1805
M. Bettoni, 19.10. 2012
19


CRITIQUE OF PURE REASON - Main parts
Kritik der reinen Vernunft - B
922
Vorrede
Einleitung
Elementar-
lehre
702
Aesthetik
Logik
661
Einleitung
Analytik
260
Begriffe
Grundsätze
180
Leitfaden der Entdeckung
Deduktion
54
Einleitung
1. Hauptst
2. Hauptst
3. Hauptst
Anhang
108
Einleitung
Erstes Buch
Dialektik
386
Zweites
Buch
347
Paralogismen
Antinomien
59
Ideal
181
Anhang
Methoden-
lehre
150
Disziplin
Kanon
Architektonik
Geschichte
50 pages = 50
M. Bettoni, 19.10. 2012
20

Broad Architecture of Mind

Mannigfaltige der Erscheinungen
- All sources of disturbances

Gemüt
- Main functional unit
- Collects all functional subunits

Functional subunits
- What Kant calls «Vermögen» (faculty)
- Part-whole realtions
- Connections

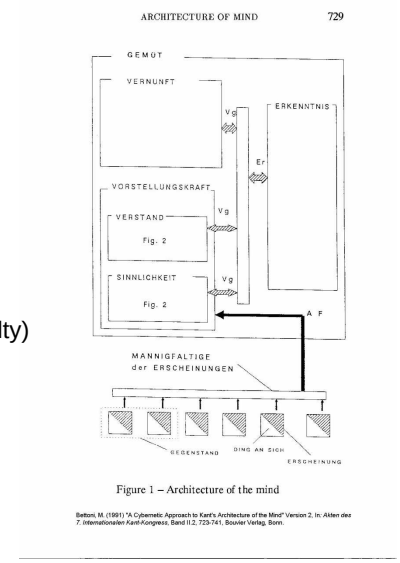


Figure 1 – Architecture of the mind

Bettoni, M. (1991) "A Cybernetic Approach to Kant's Architecture of the Mind" Version 2, In: *Akten des 7. Internationalen Kant-Kongress*, Band II.2, 723-741, Bouvier Verlag, Bonn.

21

Substitutions for the broad architecture 1/4

Nr.	KANT's term	Symb.	Cybern. classif.	SUBSTITUTIONS and original text pagings [A..., B...]
1	GEMÜT	GM	OPERATOR	Functional unit collecting all the functions involved in cognitive processing. [B 74, 75]
2	VERNUNFT	VF	OPERATOR	Functional unit generating principles. [B 24, 356]
3	VORSTELLUNG	Vg	OPERAND	Mental construct [B 33ff, 74ff, 92ff, 376]
4	VORSTELLUNGSKRAFT	VK	OPERATOR	Functional unit collecting the functions of generating mental constructs. [B 34, 51, 130]

M. Bettoni, 19.10. 2012

22

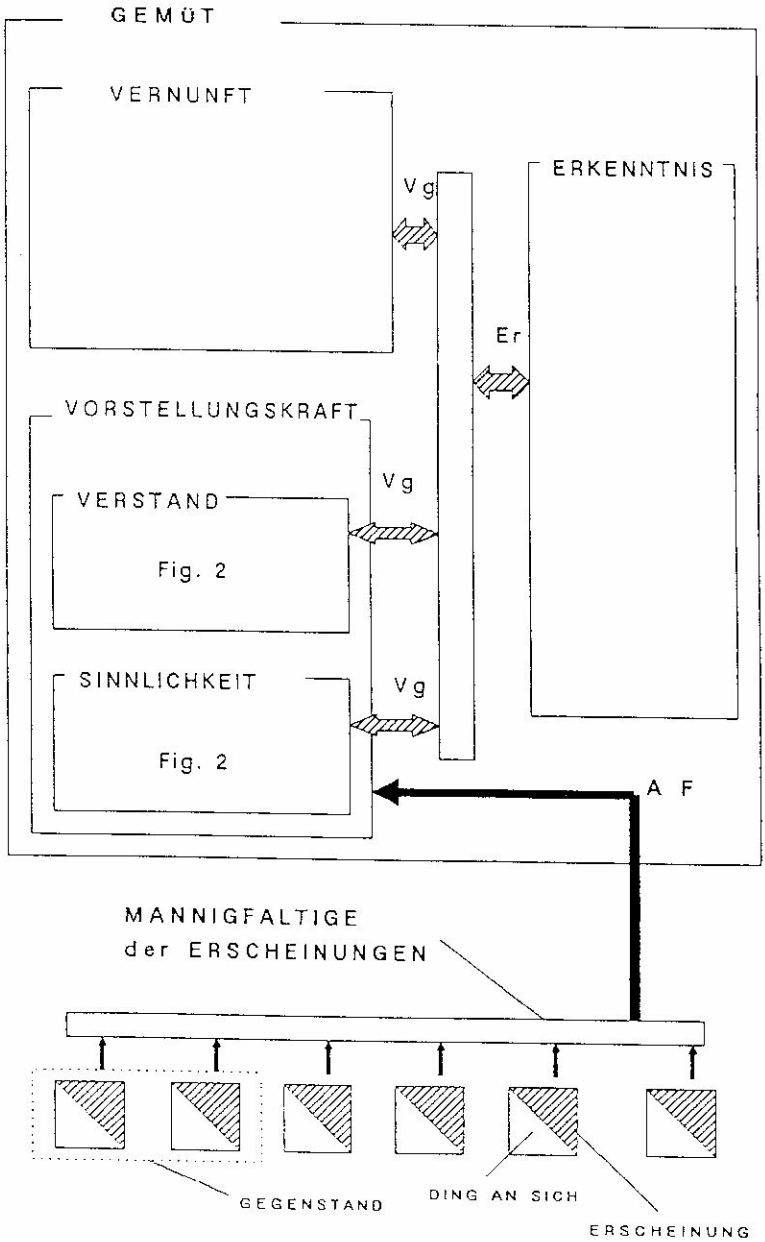


Figure 1 – Architecture of the mind

Bettoni, M. (1991) "A Cybernetic Approach to Kant's Architecture of the Mind" Version 2, In: *Akten des 7. Internationalen Kant-Kongress*, Band II.2, 723-741, Bouvier Verlag, Bonn.

Substitutions for the broad architecture 2/4

5	ERKENNTNIS	ER	WHOLE	System of integrated mental constructs. [A 97]
			OPERATOR	Functional unit integrating mental constructs into equilibrated cognitive structures. [B 1, 75, 76]
6	ERKENNTNIS	Er	OPERAND	Integrated mental construct.
7	VERSTAND	VD	OPERATOR	Functional unit collecting the functions of generating autonomously mental constructs, without depending on external disturbances. [B 75, 129, 134, 135]
8	SINNLICHKEIT	SI	OPERATOR	Functional unit collecting —among others— also the function of generating mental constructs depending on external disturbances. [B 33, 61, 65, 75]

M. Bettoni, 19.10. 2012 23

Substitutions for the broad architecture 3/4

9	AFFEKTION	Af	OPERAND	Disturbance or perturbation affecting unit SI. [B 93, 309]
		AF	OPERATION	The first steps of an operational sequence by which the unit SI interacts with MFE—disturbances. [B 93]
10	MANNIGFALTIGE der ERSCHEINUNGEN	MFE	WHOLE	All possible sources of disturbances considered as a whole, as a unit. [B 34, 236]
11	GEGENSTAND	GGS	WHOLE	An individual, limited source of disturbances collecting ERSCHEINUNG and DING AN SICH. [B XVII, XX, 33]

M. Bettoni, 19.10. 2012 24

Substitutions for the broad architecture 4/4

12	ERSCHEINUNG	ERS	PART	Part of an individual source of disturbances, which can disturb us and so become involved in the operational sequence in our mind leading to an integrated mental construct. [B XXVI ff]
13	DING AN SICH	DAS	PART	Part of an individual source of disturbances from which we cannot be disturbed. [B XXVI ff]

M. Bettoni, 19.10. 2012 25

Architecture of SINNLICHKEIT and VERSTAND

- Box = «Vermögen», «Kraft»
- Module = what is involved in «Handlungen»
- Static module: operands
- Dynamic module: operations
- Vertical bars: channels for operands
- Arrows: flow of operands
- Black arrows: flow of empirical op.
- White arrows: flow of pure operands

SINNLICHKEIT (sensibility)

VERSTAND (understanding)

VORSTELLUNGEN (mental constructs)

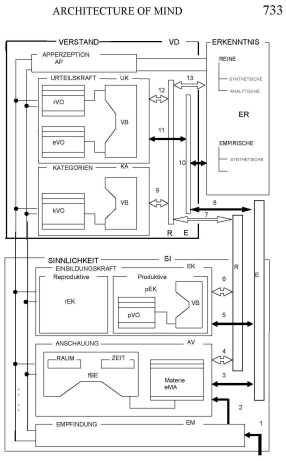


Figure 2 – Architecture of SINNLICHKEIT and VERSTAND

Bettoni, M. (1991) "Cybernetics Applied to Kant's Architecture of Mind". In G. Funke, *Akten des 7. Internationalen Kant-Kongress*, Band II.2, 723-741, Bonn: Bouvier.

26

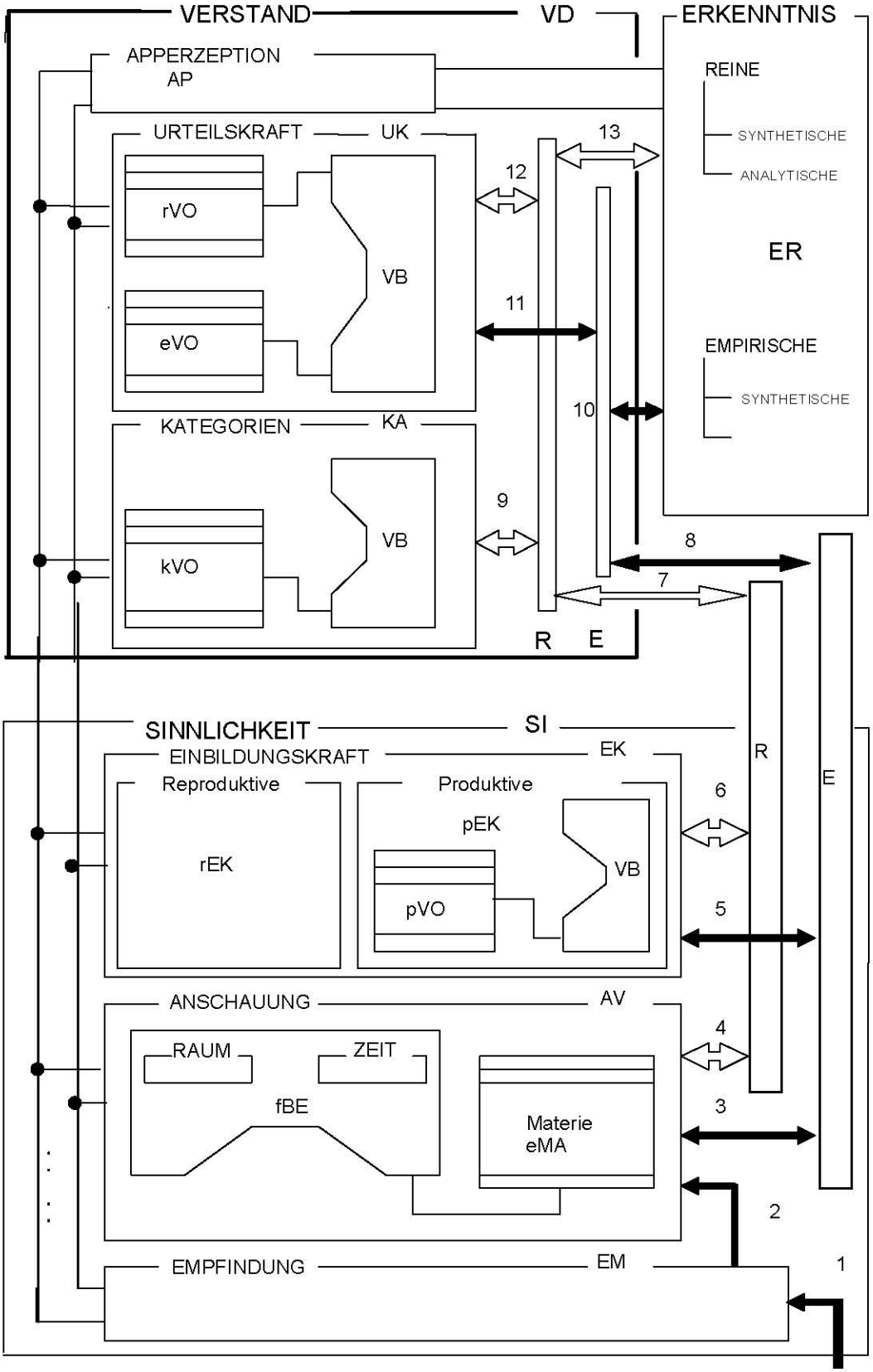


Figure 2 – Architecture of SINNLICHKEIT and VERSTAND

Bettoni, M. (1991) "Cybernetics Applied to Kant's Architecture of Mind" In: *G. Funke, Akten des 7. Internationalen Kant-Kongress*, Band II.2, 723-741, Bonn: Bouvier.

Substitutions for the detailed architecture

Nr.	KANT's term	Symb.	Cybern. classif.	SUBSTITUTIONS and original text pagings [A..., B...]
I	Bus, arrows, boxes			
1	ERKENNTNIS-VERMÖGEN	EV	OPERATOR	See Table 1
2	REINE ER-KENNTNIS	rEr	OPERAND	Autonomously generated and integrated mental construct, independently from external disturbances [B XVI, XVII, 2, 3, 33].
3	EMPIRISCHE ERKENNTNIS	eEr	OPERAND	Integrated mental construct generated by functional units among which some depend on external disturbances [B 1, 2, 3, 33].

M. Bettoni, 19.10. 2012 27

Substitutions for the detailed architecture

4	ERFAHRUNG	Ef	OPERATIONAL SEQUENCE	Sequence of operations (one of which depends on external disturbances) ending with (result) an integr. mental construct [B 1, 147, 196, 218].
5	REINE SYNTHETISCHE ERKENNTNIS	rsE	OPERAND	Integrated mental construct generated by an operational sequence containing assembling operations and independently from external disturbances [B 18, 102, 130].
6	REINE ANALYTISCHE ERKENNTNIS	raE	OPERAND	Integrated mental construct generated by an operational sequence containing dis—assembling operations and independently from external disturbances [B 18, 102, 130].

M. Bettoni, 19.10. 2012 28

Substitutions for the detailed architecture

7	EMPIRISCHE SYNTHETISCHE ERKENNTNIS	esE	OPERAND	Integr. mental construct generated by an operational sequence containing assembling operations and operations which depend on external disturbances [B 11, 196].
8	VERSTAND	VD	OPERATOR	See Table I
9	APPERZEPTION	AP	OPERATOR	Functional unit which selects and enables (= accompanies) the activities of the other units [A 94, B 132 ff].
10	APPERZEPTION	Ap	OPERAND	Result of the activity of the AP–unit [A 94, B 132 ff].

M. Bettoni, 19.10. 2012 29

Substitutions for the detailed architecture

11	URTEILSKRAFT	UK	OPERATOR	Functl. unit assembling pure and empirical mental constructs through the activation (application) of operations [B 93, 102, 104 ff, 171].
12	KATEGORIEN	KA	OPERATOR	Functl. unit assembling pure mental constructs obtained from the fBE-module and the pEK–unit [B 102 ff].
13	SINNLICHKEIT	SI	OPERATOR	See Table I
14	produktive EINBILDUNGSKRAFT	pEK	OPERATOR	Functl. unit autonomously assembling (by figurative operations) mental constructs from the AV–unit [B 150 ff, 204 ff].

M. Bettoni, 19.10. 2012 30

Substitutions for the detailed architecture

15	reproduktive EINBILDUNGSKRAFT	rEK	OPERATOR	Functl. unit generating the connection of mental constructs form the AV—unit depending on external disturbances [B 150 ff, 204 ff].
16	ANSCHAUUNGSVERMÖGEN	AV	OPERATOR	Functl. unit modulating through space— and time—operations what comes from the EM—unit [B XVII, 33, 34, 67].
17	REINE ANSCHAUUNG	rAn	OPERAND	Mental construct autonomously obtained by pure operations, independently from external disturbances [B 34 ff].
18	EMPIRISCHE ANSCHAUUNG	eAn	OPERAND	Mental construct obtained through pure operations performed on operands from the EM—unit (= perturbations) [B 33, 34].

M. Bettoni, 19.10. 2012 31

Substitutions for the detailed architecture

19	EMPFINDUNG	EM	OPERATOR	Functl. unit converting disturbances into perturbations [B 33, 34].
20	EMPFINDUNG	Em	OPERAND	Result of the activity of the unit EM = perturbation [B 33, 34].
I I	Modules			
1	VERBINDUNG	VB	OPERATOR	Component of different functional units collecting the operations of assembling (composing, binding, connecting) [B 102 ff].
2	VORSTELLUNGEN	*VO	OPERANDS	Comp. of diff. functl. units collecting operators to be sequentially processed in a VB—module (r=pure, e=empirical) [B 33 ff].

M. Bettoni, 19.10. 2012 32

Substitutions for the detailed architecture

3	BEGRIFF	BG	OPERA-TION	Assembling operation by a module [B 90, 92 ff, 102 ff]
		Bg	OPERAND	The same assembling operation, considered as a result, as a pattern.
4	formale BEDINGUNG	fBE	OPERATOR	Comp. collecting the space– and time–operations for the conditioning of perturbations [B 37ff].
5	MATERIE	eMA	OPERANDS	Comp. collecting the operators (perturbations) to be sequentially processed in the fBE–module [B 33 ff].

M. Bettoni, 19.10. 2012 33

System Dynamics: Example

- «*Wenn aber gleich unsere Erkenntnis mit der Erfahrung anhebt, so entspringt sie darum doch nicht eben alle aus der Erfahrung*» B1
- Mapping in the system model:
  - Any operational sequence starts with operations performed on external disturbances
  - But it does not follow that the whole operational sequence is all composed by that kind of operations

M. Bettoni, 19.10. 2012 34

Conclusions

- Central problem of Artificial Intelligence:
  - Knowledge representation
- *Dogmatic* AI approaches
  - In the Kantian sense
  - Do not investigate mechanisms and operations of the mind

➢ Need for progress in AI
  - ➢ investigation of our *pure* mental mechanisms
  - ➢ Knowledge as a dynamic structure
  - ➢ Operations are what represent knowledge in the brain

M. Bettoni, 19.10. 2012 35

Thank you for your attention!

Source of picture: http://www.allmystery.de/themen/rs20559-357#beitrag246899054

36

KANT'S TERMINOLOGY

A priori/posteriori	- *Middle Age: demonstration from the former, cause / from the latter, effect* - *Aristoteles: what is general, universal, distant / specific, individual, near* - (elements of) knowledge supplied from the mind / from processing sense impressions
A priori	- properties: necessity, universality, independent from experience, NOT innate !
Transcendental	- knowledge about our 'a priori' mode of mental activity (knowing)
"Anschauung"	- FRAMING (as a faculty, as a product); "Rasterung", screening. - Russell: translation with 'intuition' NOT satisfactory
Empirical	- of knowledge obtained in the 'a posteriori' mode - of framings (frames) and concepts when they contain sensation
Pure	- of knowledge made completely of a priori elements - of framings and concepts when they do not contain any sensation
"Vorstellung"	- MENTAL PATTERN, product or construct; (Locke: idea) - von Glasersfeld: translation with 'representation' NOT satisfactory
Knowledge	- a whole made of compared and connected mental products [A 97]
Manifold	- a raw material on which a synthetic function operates unity; variety as a whole
Thing in itself	- an empty concept without experiential object (fiction, virtual object) - heuristic function: thinking of sensations as having causes
"Gegenstand"	- OBJECT IN FIERI, which becomes 'object in facto' = OBJECT FOR ME

M. Bettoni, 19.10. 2012 37