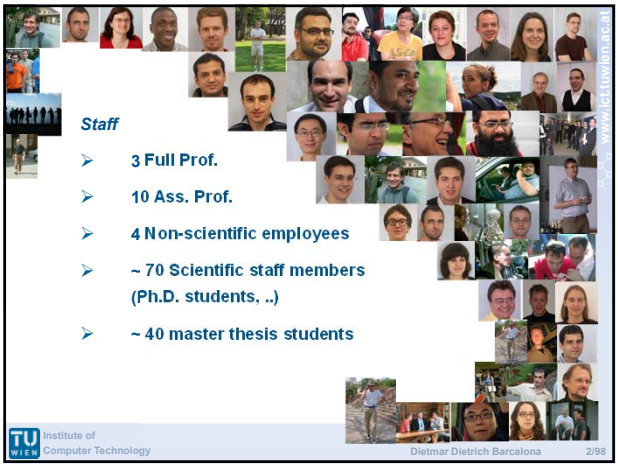
TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Institut für Computertechnik
Institute of Computer Technology

Function Model of a Control Unit

A Bionic Approach

Dietmar Dietrich

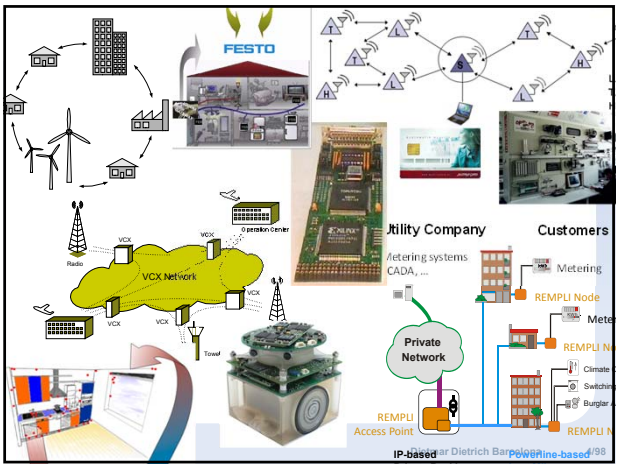


Staff

- 3 Full Prof.
- 10 Ass. Prof.
- 4 Non-scientific employees
- ~ 70 Scientific staff members (Ph.D. students, ..)
- ~ 40 master thesis students

Research and education (Dietrich)

- Computer networking
- Smart Power Grid
- Psychoanalytic oriented AI (=ΨAI)
- ASIC design
- Fault tolerant systems



We are vice-president, chair, convenor, delegate, member, .. in various organizations

- OVE (Past Vice President)
- OGMA (Past Member of the advisory board)
- IEEE Past Section Austria chair
- IEEE IES TC BACM past chair
- IEEE IES ADCOM past member
- Ass. Editor in IEEE IES TIE
- Ass. Editor in EURASIP
- ASA (Member of the advisory board)
- CENELEC TC65 CX (delegate) CEN TC247 (Delegate)
- CEN TC247 WG4 (Convenor)
- OVE TC65 CX (Member)
- ON FNA 058 (Member)
- LonMark Audit (Past Member)
- ISO TC205 (Member)

ΨARSini
ARS international initiative

Artificial Recognition Systems

→ ΨAI

ARS Project Team


Dietmar Dietrich


Dietmar Bruckner


Tobias Deutsch


Klaus Doblhammer


Georg Fodor


Heimo Zeilinger


Zsofia Kovacs


Isabella Hinterleitner


Friedrich Gelbard


Andreas Perner


Clemens Muchitsch


Alexander Wendt


Stefan Kohlhauser


Matthias Jakubec


Christian Brandstätter

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Preface

Dietmar Dietrich Barcelona 7/98

Possibilities..

.. to present:

1. A research result
2. Overview of a specific science area
3. ..
4. The main challenge
   in which I see the biggest chance for research work within the next 100 years

The main challenge: How to get intelligence?

The paradigm shifts/the principle idea behind it/the traps/..

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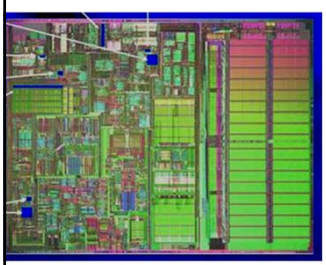
Dietmar Dietrich Barcelona 8/98



100.000.000 transistors

10.000.000.000 neurons

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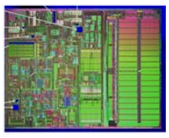

What is doubtful of the announcement of several newspapers:
(about the (IBM) Blue Brain Project, 2008)

"We are able to simulate 2 billion neurons. We are able to simulate the brain very soon."

?

Comparison: bad & wrong

1. Transistor = neuron?
2. Structures, functions, layers, ..??

What are "intelligent" systems?

Do we need intelligence or even
conscious thinking?

Many say: NO!

Agenda

1. Motivation & Task Setting
2. From Mechanical to Information Thinking
3. Traps in Information Systems
4. Why Psychoanalysis?
5. The new Model
6. Support of psychoanalysis by ΨAI
7. Conclusion

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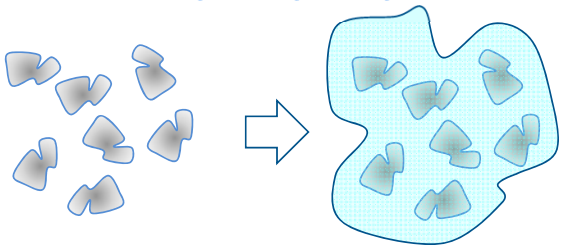
1

Common new Idea:

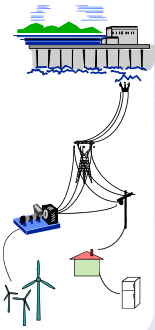
Cyber Physical Systems

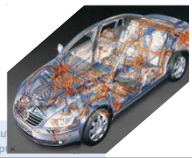


Single processes ..... to .....(complex) systems

Motivation & Task Setting

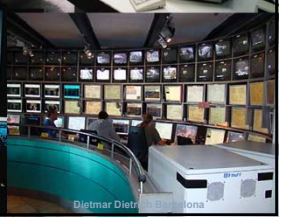
- Energy management systems
- Building automation
- Industrial automation
- Process automation
- Air & space technology
- Automotive industry
- Cargo industry
- Safety & security
- ..





Who decides finally?

A human being!



Who decides finally?

A human being!

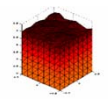
Need for human intelligence

Bionic approach

Application Example: How to achieve energy efficiency

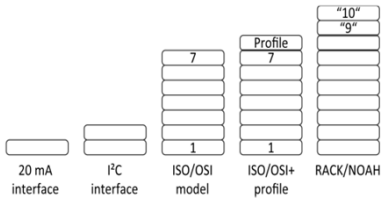
- Reduce energy losses
  - Better thermal insulation
  - Keep temperature differences low
- Switch off unused services
- Use energy, when available

► Automation ► Intelligence



Communication Example Layered Models of Intelligent Systems

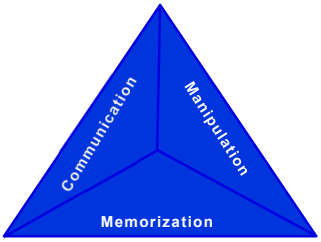
Layered communication model



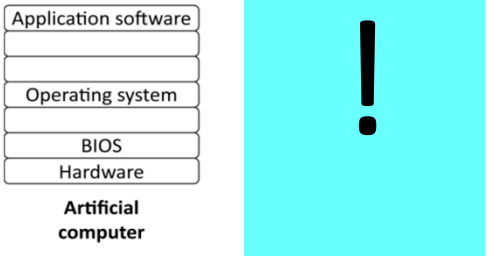
The Requirement

Computer

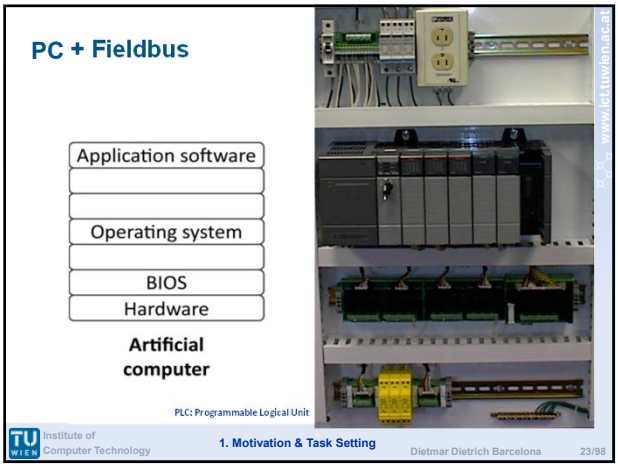
Definition of a Computer:



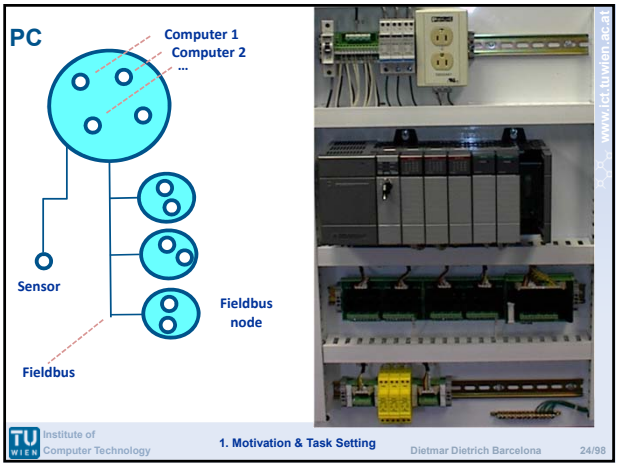
Layered Model of a Computer (Intelligent System)



PC + Fieldbus



PC

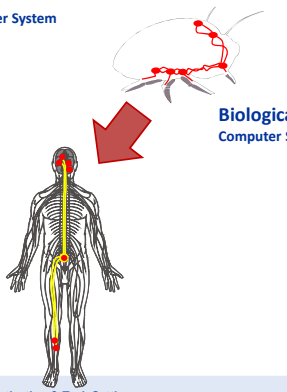


PC

Artificial
Computer System

PC

Artificial
Computer System



Biological
Computer System

The question:

How to build a
model
of the human psyche

to understand the
principles of intelligence?

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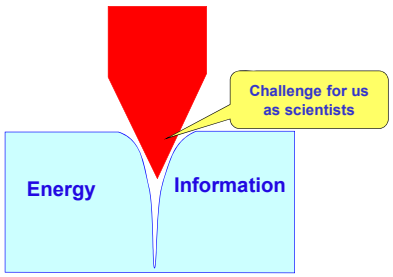
2

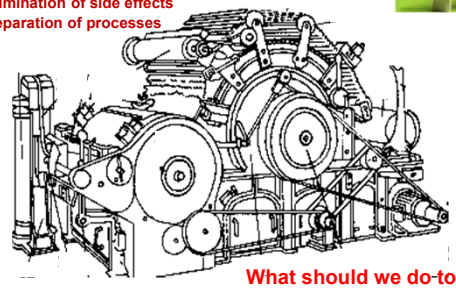
Differentiation of energy & information flow

Example: steering wheel



Clock of
Leonardo da Vinci

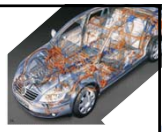
- Up to now: ingenious mechanics
- Problems:
  - Linearization
  - Reduction (abstraction) to decisive parameters
  - Elimination of side effects
  - Separation of processes
  - ..

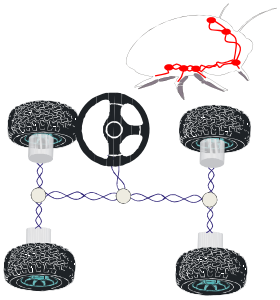


What should we do-today?

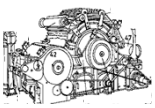
Today

- Reduction to (mathematical) description
- But ..





Reduction of the mechanic parts to a few components with a huge number of sensors.



HMI

Computer

process

- Problems will be "moved" more and more to the computer.
- Abstract systems can be manipulated easier and more precisely.

Constraints:

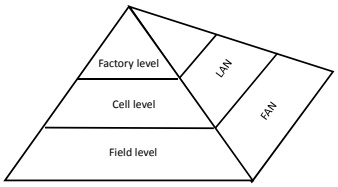
more knowledge of processes
= dramatically increasing number of sensors

Layered Models of Intelligent Systems

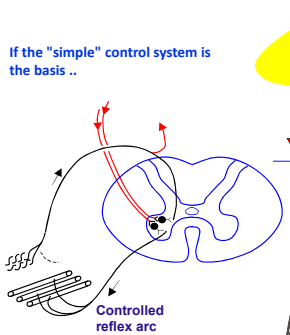
Specific description language (SDL)

- System
- Block
- Process
- Macro

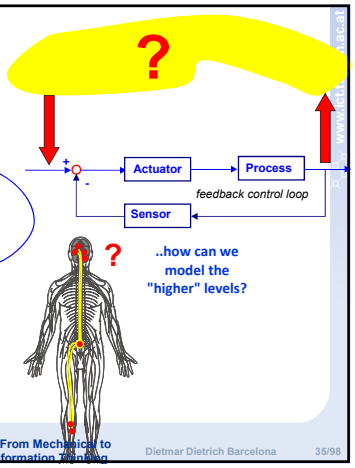
Automation pyramid



If the "simple" control system is the basis ..



Controlled reflex arc



Bionic world

Layered Models of Intelligent Systems

Artificial computer	Biological computer
Application software	Super Ego, Ego, Id
	?
Operating system	
BIOS	Neuro symbolic
Hardware	Neural networks

Problems?

Artificial computer

Biological computer

Principle

Thinking

Natural science

Humanities / Social science

not explainable by natural science

handling physics, biology, .. measurable, possible to simulate, ..

► ***possible to define a model***

Information Theory: Logic

Bertrand Russel

Axioms (Postulates):

Disjunction: 0 V 1 = 1

Conjunction: 0 Λ 1 = 0

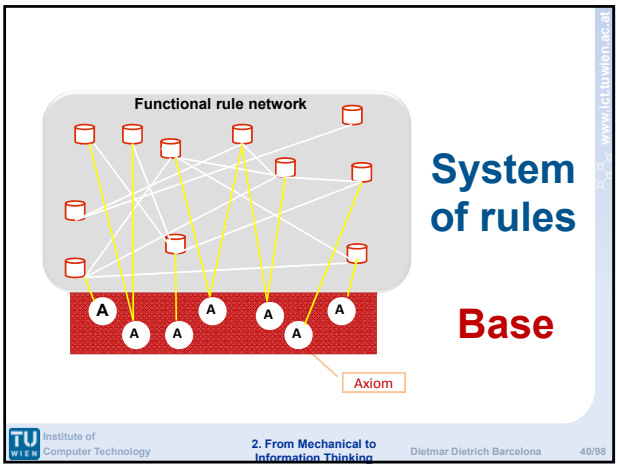
Rules:

Disjunction: 0 V a = a

Conjunction: 0 Λ a = 0

Base

System of rules


Functional rule network
A
A
A
A
A
A
A
Axiom
System of rules
Base
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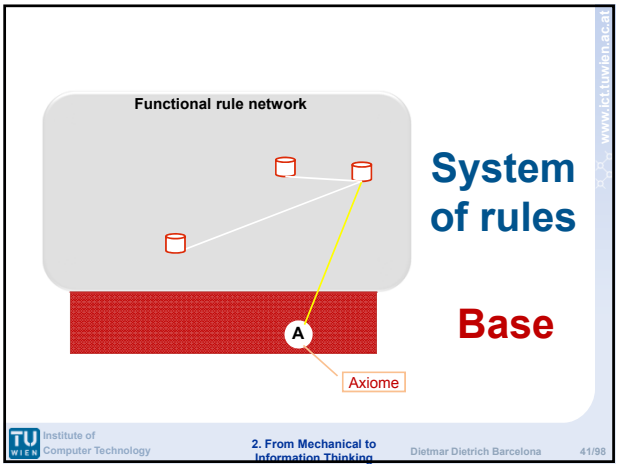
Functional rule network
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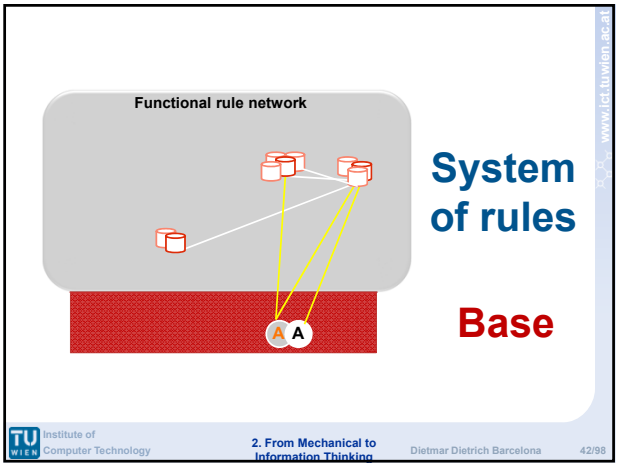
Functional rule network
A
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System of rules
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Layered Models of Intelligent Systems

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Application software	Super Ego, Ego, Id
	?
Operating system	
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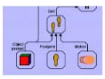
3

Artificial Intelligence Approaches

Historically: Bottom-up

- Symbolic Artificial Intelligence
  - *Incoming sensor data → symbolized & manipulated*
  - Mental apparatus: comparable to lowest functional level
- Statistical Artificial Intelligence
  - *Artificial neural networks → Main function: learning*
  - Mental apparatus: comparable to lowest functional level
- Behavior-based Artificial Intelligence
  - *Embodied intelligence → behavior*
  - Mental apparatus: comparable to lowest functional level
- Emotion-based Artificial Intelligence
  - *Valuation of images, scenarios, .. (incoming computed data)*
  - Mental apparatus: comparable to higher functional levels



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3.1 **Bottom-up** *versus* **Top-Down Design**

Observation of process behavior

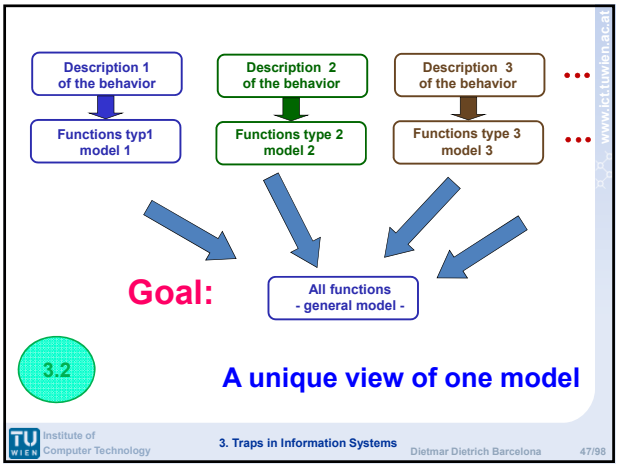
Model finding

Experiment

Model verification/modification

Experiment

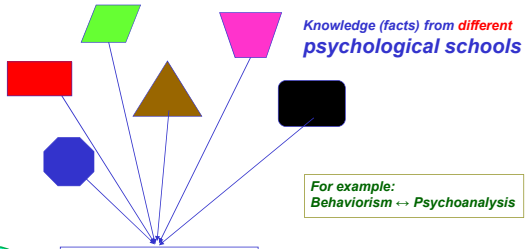
3.2



3.2

A unique view of one model

Necessity: a unitary Model .. & NOT a patchwork



Knowledge (facts) from different psychological schools

For example: Behaviorism ↔ Psychoanalysis

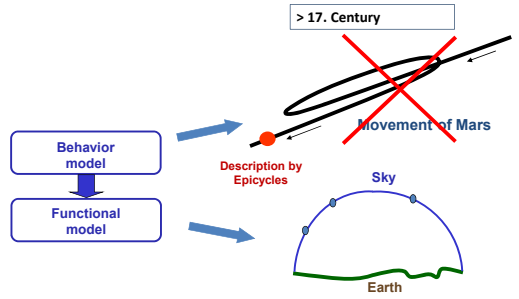
3.2

Unitary model for computer implementation

..on the basis of a Top-down Design

The Choice of the Correct Model

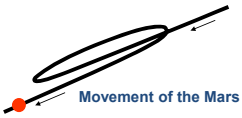
3.3



The Choice of the Correct Model

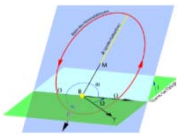
3.3

.. but Kopernikus:



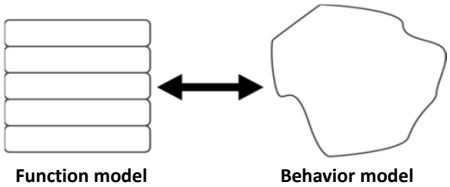
Behavior model

Functional model



Behavior-based Analysis

3.4

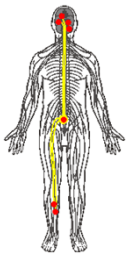


- Copying behavior is not a choice
- Adjust functional model until behaviour matches

Behavior model *versus* Function model

3.4

Function ↔ Behavior ↔ Projection



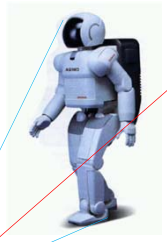
3.4

Function model ↔ Behavior ↔ Projection

Ego, Id, Super-Ego

?

Hardware (Neurons)



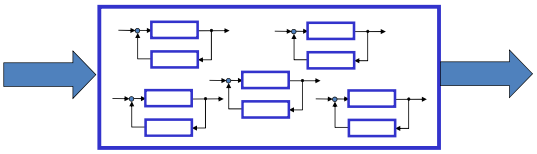
3.4

Function model ↔ Behavior ↔ Projection

CB2

Concerning the human psyche?

Statistical Methods
Artificial Intelligence/Cognitive Science



3.5

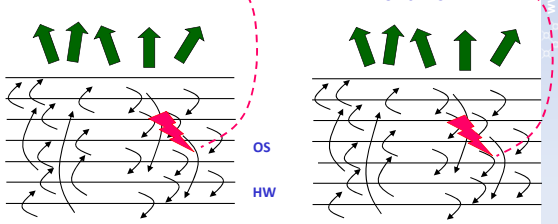
Impossible to describe precisely the BEHAVIOR
of a multiple control system with unknown dependences

Techn. computer

Brain

Behavior

Behavior ?



3.5

Impossible to describe precisely the BEHAVIOR
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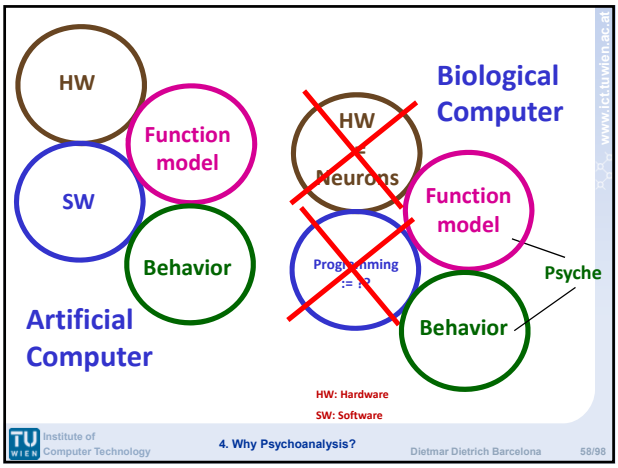
HW
Function model
SW
Behavior
Artificial Computer
Biological Computer
HW
:= Neurons
Function model
Psyche
Behavior
HW: Hardware
SW: Software
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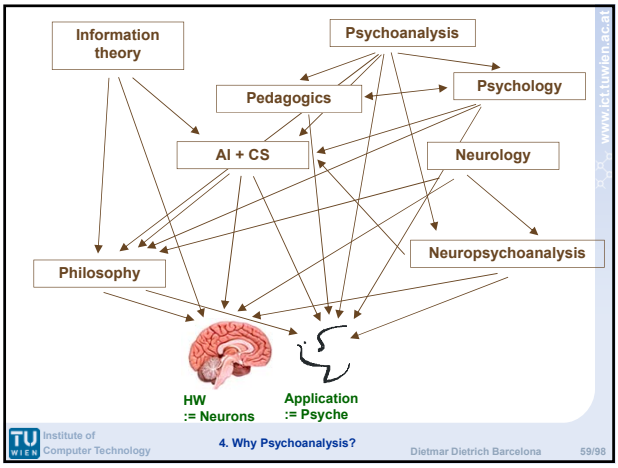
Information theory
Psychoanalysis
Pedagogics
Psychology
AI + CS
Neurology
Neuropsychoanalysis
Philosophy
HW
:= Neurons
Application
:= Psyche
Institute of Computer Technology
4. Why Psychoanalysis?
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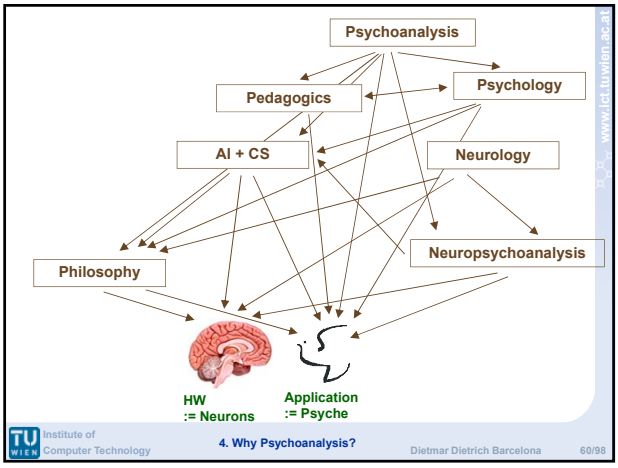
Psychoanalysis
Pedagogics
Psychology
AI + CS
Neurology
Neuropsychoanalysis
Philosophy
HW
:= Neurons
Application
:= Psyche
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4. Why Psychoanalysis?
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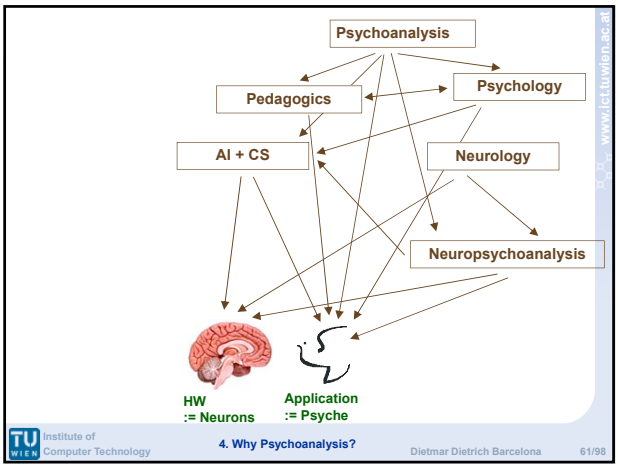
Psychoanalysis
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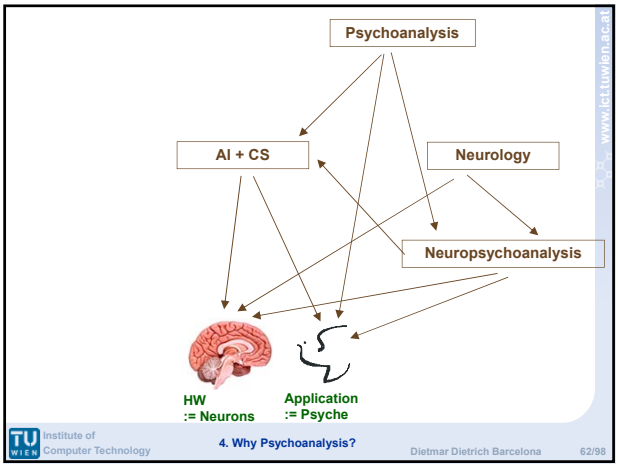
Psychoanalysis
AI + CS
Neurology
Neuropsychoanalysis
HW
:= Neurons
Application
:= Psyche
Institute of Computer Technology
4. Why Psychoanalysis?
Dietmar Dietrich Barcelona
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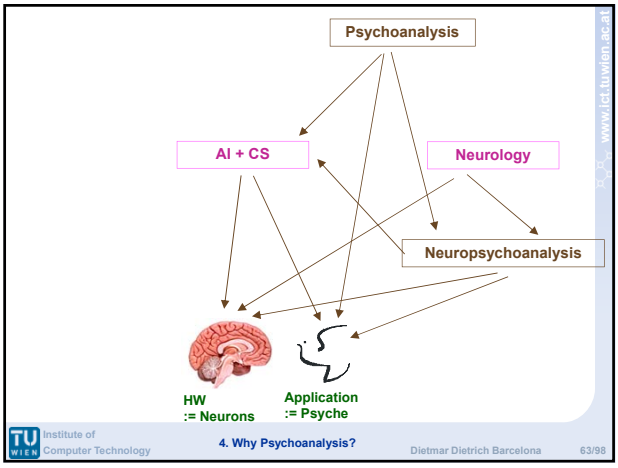
Psychoanalysis
AI + CS
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:= Neurons
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4. Why Psychoanalysis?
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Neuropsychoanalysis

- Philosophy
- Biology
- ..
- Vienna: 17 psychological schools

Sigmund Freud
Austria, UK

Mark Solms
RSA, UK + USA

Alexander R. Lurija
Russia

Antonio Damasio
USA

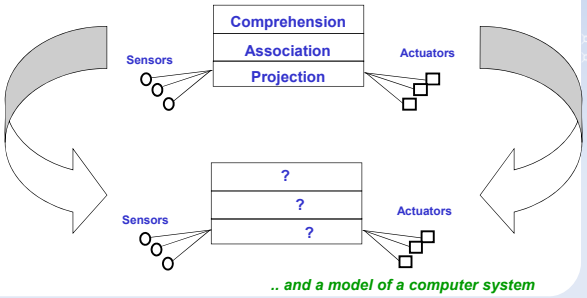
Agenda

1. Motivation & Task Setting
2. From Mechanical to Information Thinking
3. Traps in Information Systems
4. Why Psychoanalysis?
5. **The new Model**
6. Support of Psychoanalysis by ΨAI
7. Conclusion & Vision

5

The new Model

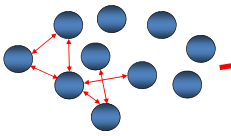
First approach:
Luria's hierarchical model of cortical functions ..

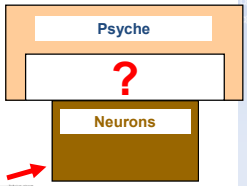


.. and a model of a computer system

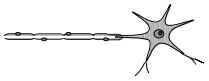
Three complementary sub-models

1. Model of psychoanalysis
   Functions, conversation, ..

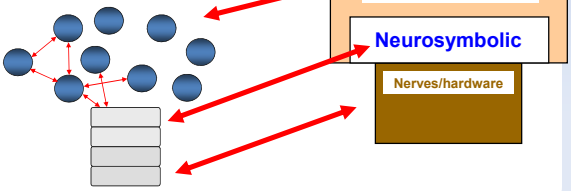




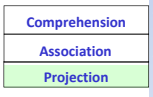
3. Model of neurology
   Nerves, physiological centers. ... medicine

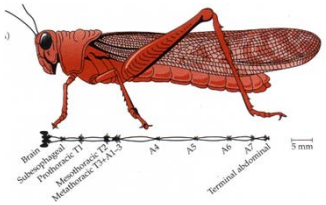


Three complementary sub-models

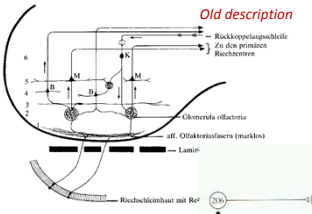


Projektionsfeld = Control Field



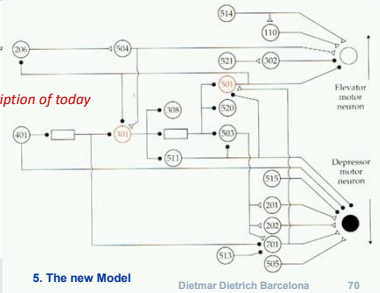


Old description

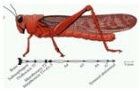


Comprehension
Association
Projection

Description of today



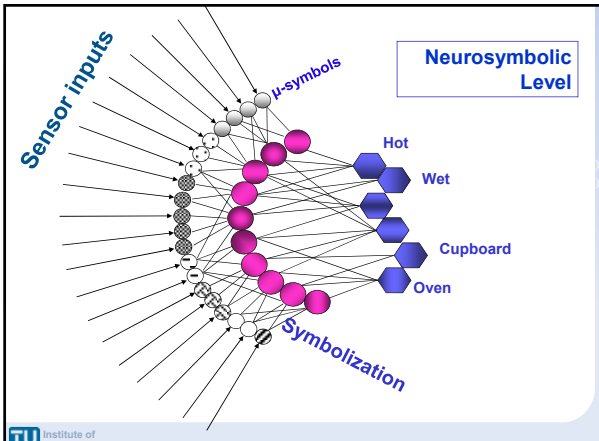
Problem ► to get the knowledge of the association field



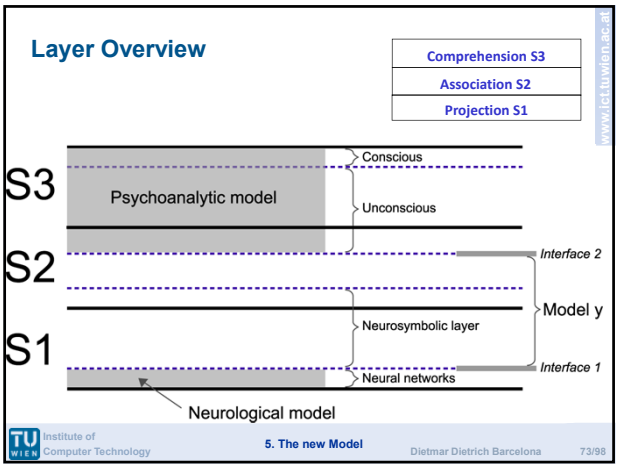
?

MRT, ..?

Comprehension
? Association
Projection

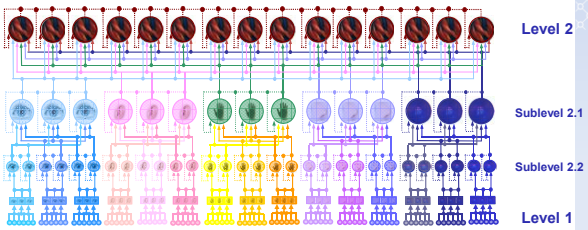


Layer Overview

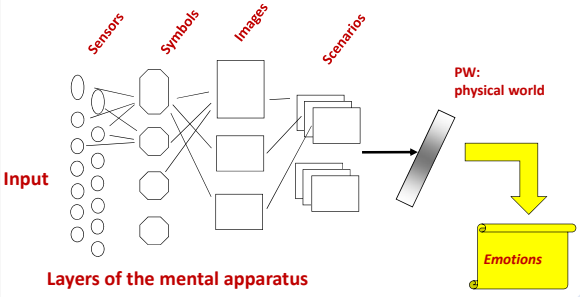


Neurosymbolic Layer

From Sensor inputs → "objects" like *hot, cupboard, human being, ...*



Intelligence of the core consciousness



Layers of the mental apparatus

Three different Kinds of Intelligence
(rough approximation on the base of the results of Damasio)

(1) Intelligence of the basic neuronal circuits ≈ 1,000 n

► (Grasshoppers)

(2) Intelligence of the **core consciousness** ≈ 1,000,000 n

► (Bird)

(3) Intelligence of the **extended consciousness** ► ≈ 1,000,000,000 n

(Mammals)

n := neurons

Three different Kinds of Intelligence
(rough approximation)

(1) Intelligence of the basic neuronal circuits 1,000 n

Base ► *control algorithms, simple decision modules*

(2) Intelligence of the **core consciousness** 1,000,000 n

Base ► *learned knowledge valued by* *Emotions*

(3) Intelligence of the **extended consciousness** 1,000,000,000 n

n := neurons

Three different Kinds of Intelligence
(rough approximation)

(3.1) Intelligence of the **extended consciousness** 1,000,000,000 n

Base ► *learned knowledge & the ID valued by* *Feelings* *Time*

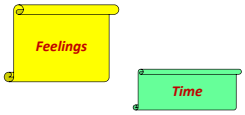
n := neurons

Three different Kinds of Intelligence

(rough approximation)

(3.1) Intelligence of the **extended consciousness**

Base ►.. *valued by*



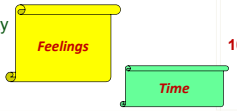
1,000,000,000 n

= 10^9 n

(3.2) Intelligence of the **extended consciousness**

with speech capability

Base ►.. *valued by*



10,000,000,000 n

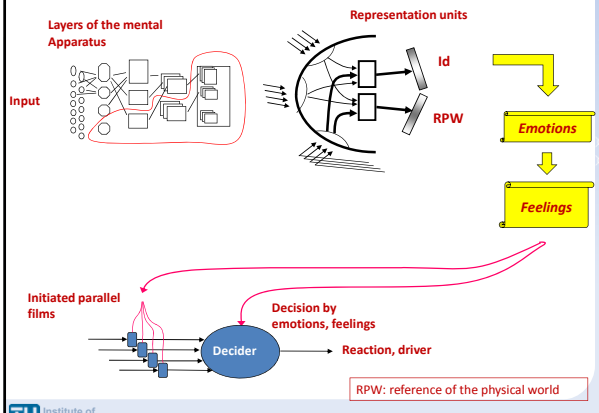
= 10^{10} n

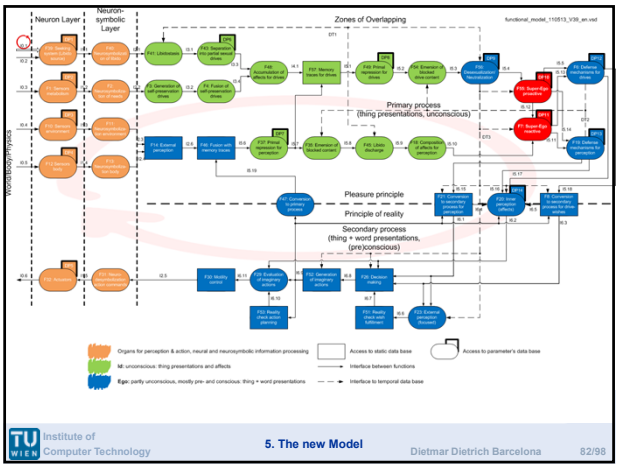
Difference between Intelligence

(very rough approximation)

Worm:		300 n ≈	0.3* 10^3 n
Eye of a fly:	3 * 300 n ≈	800 n ≈	0.8* 10^3 n
Fly:	4 * 800 n ≈	2,000 – 5,000 n ≈	3.5* 10^3 n
Grashopper:	2* 5,000 n ≈	10,000 n =	10^4 n
Bird:	100* 5,000 n ≈	1,000,000 n =	10^6 n
Mammal:	1,000* 10^6 n ≈	1,000,000,000 n =	10^9 n
Human being:	10* 10^9 n ≈	10,000,000,000 n =	10^{10} n

n := neurons




Neuron Layer
Neuron-symbolic Layer
Zones of Overlapping
Primary process
(thing presentations, unconscious)
Pleasure principle
Principle of reality
Secondary process
(thing + word presentations,
(pre)conscious)
Institute of Computer Technology
5. The new Model
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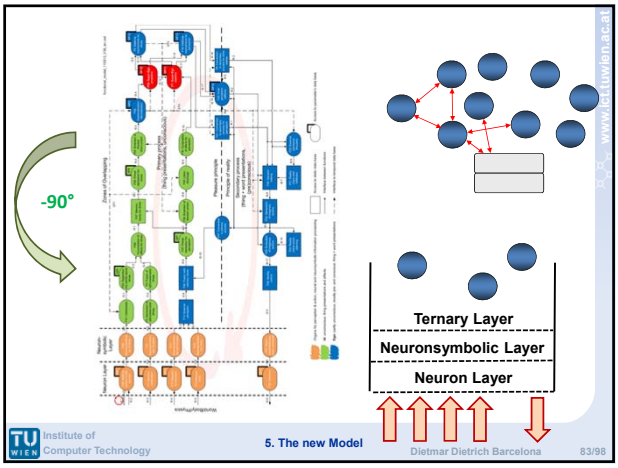
-90°
Ternary Layer
Neuronsymbolic Layer
Neuron Layer
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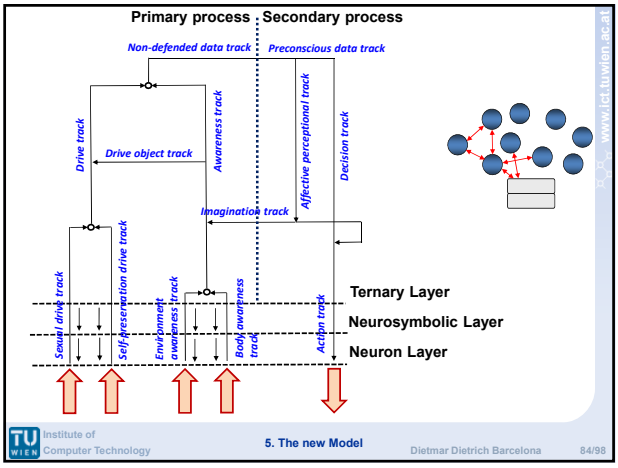
Primary process
Secondary process
Non-defended data track
Preconscious data track
Drive track
Drive object track
Awareness track
Affective perceptional track
Decision track
Imagination track
Sexual drive track
Self-preservation drive track
Environment awareness track
Body awareness track
Action track
Ternary Layer
Neurosymbolic Layer
Neuron Layer
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F21-Conversion to secondary process for perception
Responsible: Stefan Kohlhauser (SK)

Interfaces

Name	Contents	Direction
I5.15	Awareness (external awarnes objects) (TP + emotions + affect amount (Lust, Unlust) - alle parallel vorhanden + erlebt und erinnert)	In
I6.9	Action plans (feelings + think presentations+symbol presentations)	In
DS21	word presentations – handover of primary data structures	In/Out
DT3	neutralized Drive energy (psyche energie) / Information concerning for the distribution to moduls is added	In

Sub-Funktionen

F21.1	Consumes psyche energy
F21.2	Psyche energy modulate the funktionality
F21.3	..
F21.4	
..	

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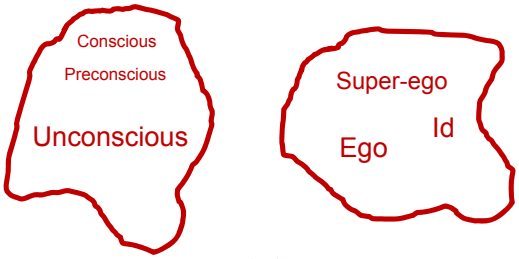
6

Contradiction
between the two models in psychoanalysis



1. topographical model ⇄ **2. topographical model**

Topographical Model of Psychoanalysis

Function model

of Hardware, Software, ..
(is physically the same)

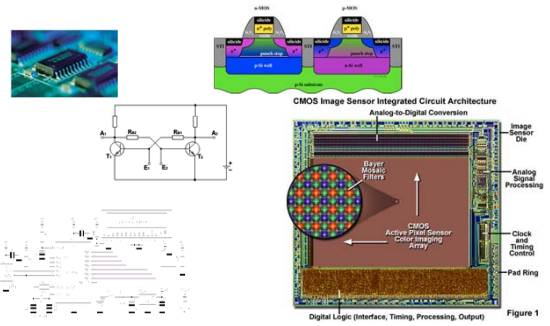
2. topographical model: Ego, Id, Super-ego

Data

Contents of the functional units (= text, numbers, ..)
have attributes, properties, (= green, conscious, ..)

1. topographical model : images, scenarios, ..

Function Units



.. and the data?

Functions ↔ Data

What are data?
What are functions?

Functions ↔ Data

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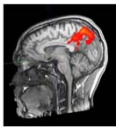
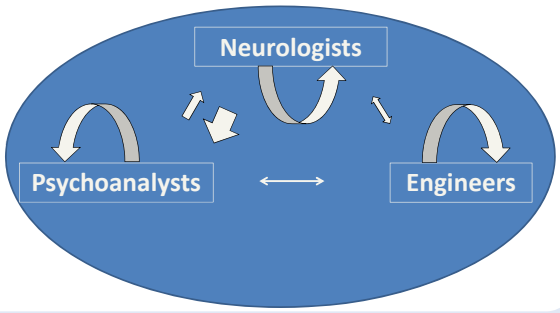
7

Conclusions

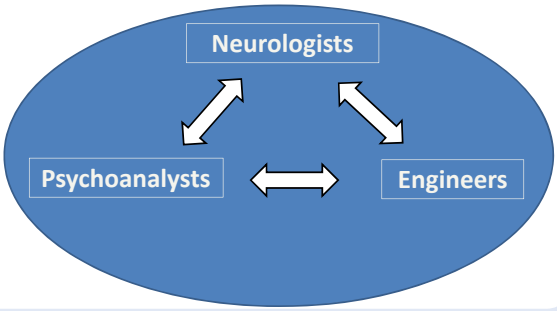
- **Psyche: abstract layered system**
- **Central idea: control systems**
  continuously competing forces
- **A huge distributed system & data base of images & scenarios**
- **..**
- **Possible to simulate**

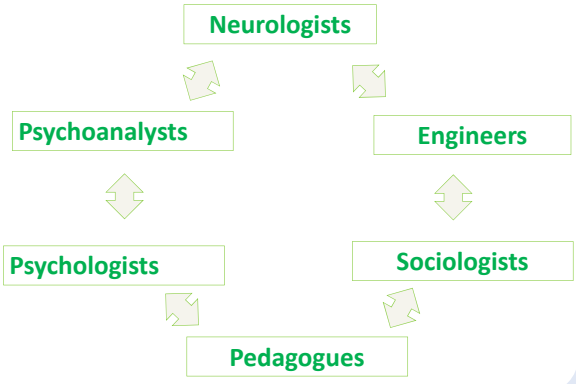


The biggest problem:

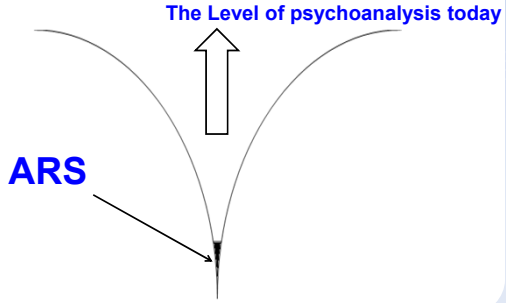


The Dream:

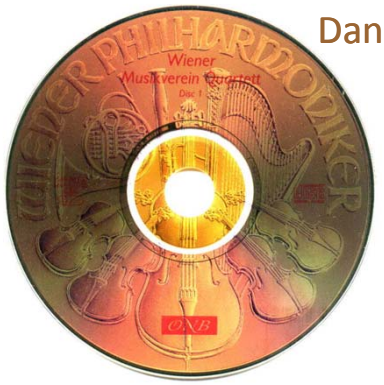




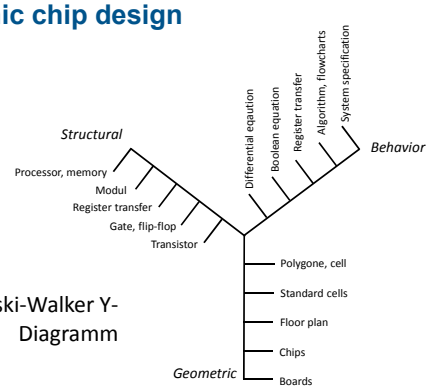
Status of the Model & Implementation



Danke!



Electronic chip design

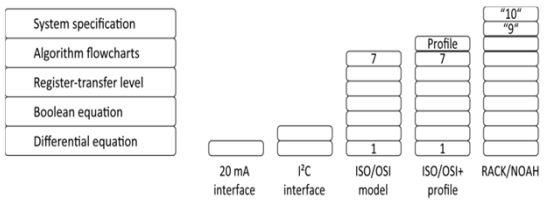


Gajski-Walker Y-Diagramm

Layered Models of Intelligent Systems

1 arm of the layered Gajski-Walker Y-Diagramm

Layered communication model



Top-down Design

3.5