

# The 'Excellence Initiative' and the Restructuring of German Universities

## Introductory Remarks

The TUM Approach

Research Cluster *CoTeSys*

Final Remarks

# Abstract

After many decades of a standstill in our educational systems and endless discussions on the future of academic and non-academic education, Germany – like many other countries - is in a process of restructuring on all levels of education. The presentation will discuss some of the overall driving forces behind this development and the specifics of the German situation, because of its political organization as a Federal system with the administrative sovereignty for cultural affairs and education with each of the 16 German states (Länder). Besides a reduction of primary and secondary education from 13 to 12 years or the introduction of Bachelor/Master degree system as required by the European Union, the *Excellence Initiative*, as inspired by the Federal Government around 2003, implements a highly competitive element in the German university system. We will discuss the general ideas, concepts and basic instruments of the Excellence Initiative for stimulating top-level academic research, and present in some detail its impact on my home university. The TU München was one of the three universities selected by an internationally composed jury as a candidate for gaining the status of an *Elite University* over the period 2006-2011. The main focus will be on some topics of a Research Cluster in the field of *Cognitive Technical Systems (CoTeSys)*, which is coordinated by the current Director of the Institute of Automatic Control Engineering.

# Background

**Federal Republic of Germany: 16 States = Länder**

**Unification of East and West, 1989**

**Federal Government: Nation-wide Optimization**

**State Governments: State-wide Optimization**

**Sovereignty with *Cultural and Educational Affairs* is with the 16 States, e.g. 16 different University Laws**

**Competiton:**    Federal <---> States  
                    State    <--->    State

**Influence of the European Union**

# Background, cont'd

## EU Lisbon Declaration 2000

***“The Union has set itself a new strategic goal for the next decade: to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion.”***

- Establishing an European Area of Research and Education
- Living and Working in the Knowledge Society
- Knowledge-driven economies

**Competition within Germany,  
within the Greater European Union,  
on the global scale**

<b>Germany</b>	<b>Premium Economy</b>
	<b>Top Export Nation</b>
	<b>Lack of natural resources</b>

## **Germany has a strong and highly differentiated Science System**

- > 100 research-intensive Universities, however with differing strengths and competences
- Max Planck Society, e.g. System Biology, .....
- Fraunhofer Society, e.g. IIT, Robotics, Automation, .....
- Helmholtz Association, e.g. Aerospace, Robotics, Mechatronics .....
- Leibniz Association, e.g. Deutsches Museum
- >250 colleges and Universities of Applied Science

 **No. 3 Research Nation**

- **Total Scientific Staff: 270,000**
- **International Researchers in Germany: > 21,000**
- **Sponsoring Agencies**
  - German Research Foundation (DFG)
  - Alexander von Humboldt Foundation (AvH)
  - German Academic Exchange Service (DAAD)
  - Numerous others

“social skills in international relationship”:

## Medizintechniker aus Chile erhält DAAD-Preis 2007



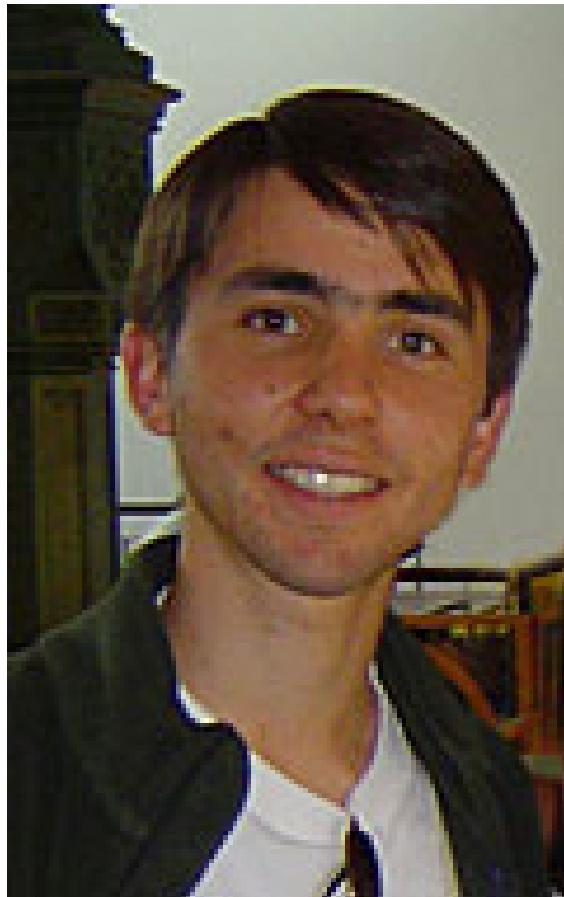
Thomas Wender Vidal

07.12.2007, *Aktuelle Meldungen*

Am Freitag, den 7. Dezember 2007, wird Thomas Wendler Vidal, Promotionsstudent am Lehrstuhl für Informatikanwendungen in der Medizin (Prof. Nassir Navab) der TUM der DAAD-Preis 2007 verliehen. Der Medizintechniker besticht durch exzellente Leistungen im Studium und hat zugleich hervorragende „social skills in international relationship“. Prof. Ulrich Wagner, Dekan der Fakultät für Elektrotechnik und Informationstechnik, überreicht den Preis um 16.00 Uhr in der Immatrikulationshalle am Stammgelände an der Arcisstraße.

Thomas Wendler Vidal wurde 1980 in Chile geboren und ging auf die Deutsche Schule in Valparaiso. Sein Abitur legte er an der Humboldtschule in Costa Rica mit einer glattten 1 ab und erhielt eine Ehrung für das beste Abitur des Jahres. Von 1999 bis 2003 studierte er an der Universidad Técnica Federico Santa María (UTFSM) in Valparaiso - inzwischen eine Partneruniversität der TUM - und bekam 100 von 100 Punkten für seine Abschlussarbeit.

2004 kam er an die TUM, um im Dezember 2006 den Master of Science in Medizintechnik zu erwerben, wieder mit der Note 1. Seit Februar 2007 ist er als Promotionsstudent eingeschrieben. Zusammen mit seinen "Doktorvätern" hat Thomas bereits einige fachspezifische Publikationen veröffentlicht. Neben seiner wissenschaftlichen Karriere war der Chilene immer auch stark sozial engagiert. So ist er nicht nur Mitarbeiter beim Bayerischen Roten Kreuz, sondern seit Februar 2005 auch als Tutor bei TUM international (TUMi), dem Betreuungsprogramm des International Office für ausländische Studierende, aktiv. Auch hier fällt er durch überdurchschnittliches Engagement und ein immer freundliches und gutgelautes Wesen auf. Ein Gewinn, heißt es in der Laudatio: "In summary, scientifically and socially, it is a great pleasure to have Thomas in our group."



**Thomas Wender Vidal**

# Education, Research and Innovation in Germany

## Intensive Political and Academic Discussions and First Reforms

- Pre-school education,  
e.g. < 6 years old children, integration of immigrants
- Primary and Secondary Education,  
e.g. from 13 to 12 years until graduation
- The '*Dual System*' Vocational Education: and Training,  
'Made in Germany'
- Role of University and Fachhochschule (Engineering School)
- Establishment of European-wide Bachelor/Master System
- *Universities of Excellence* or *Elite Universities* on global scale  
e.g. '*Excellence Initiative*'
- FedMinEduRes: '*The High-Tech Strategy for Germany*'

## Basic Objectives of the *Excellence Initiative*

- Promote top-level research
- Improve quality of German universities and research institutions

Thereby

- Making a significant contribution to strengthening science and research in Germany in the long term
- Improving its international competitiveness
- Raising the profile of top performers in academia and research on a global scale

# Initiative of the *Federal Government* in cooperation with the *State Governments*

**Managed by Federal Science Council and DFG**

**3 Funding Lines**

**2 Stages: Draft (Short) Proposal, Full Proposal**

**2 Rounds: 2006 and 2007**

**Highly competitive procedure**

**Selection by Groups of High-Level Academic Experts,  
50% International, 50% German)**

**Minor political influence,  
Autonomous decision by scientific community**

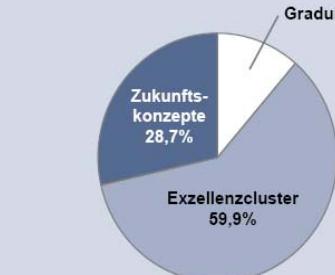
# Grants according to the 3 Funding Lines

Bewilligungen nach Förderlinien

**10<sup>9</sup> Euros  
over 5 years**



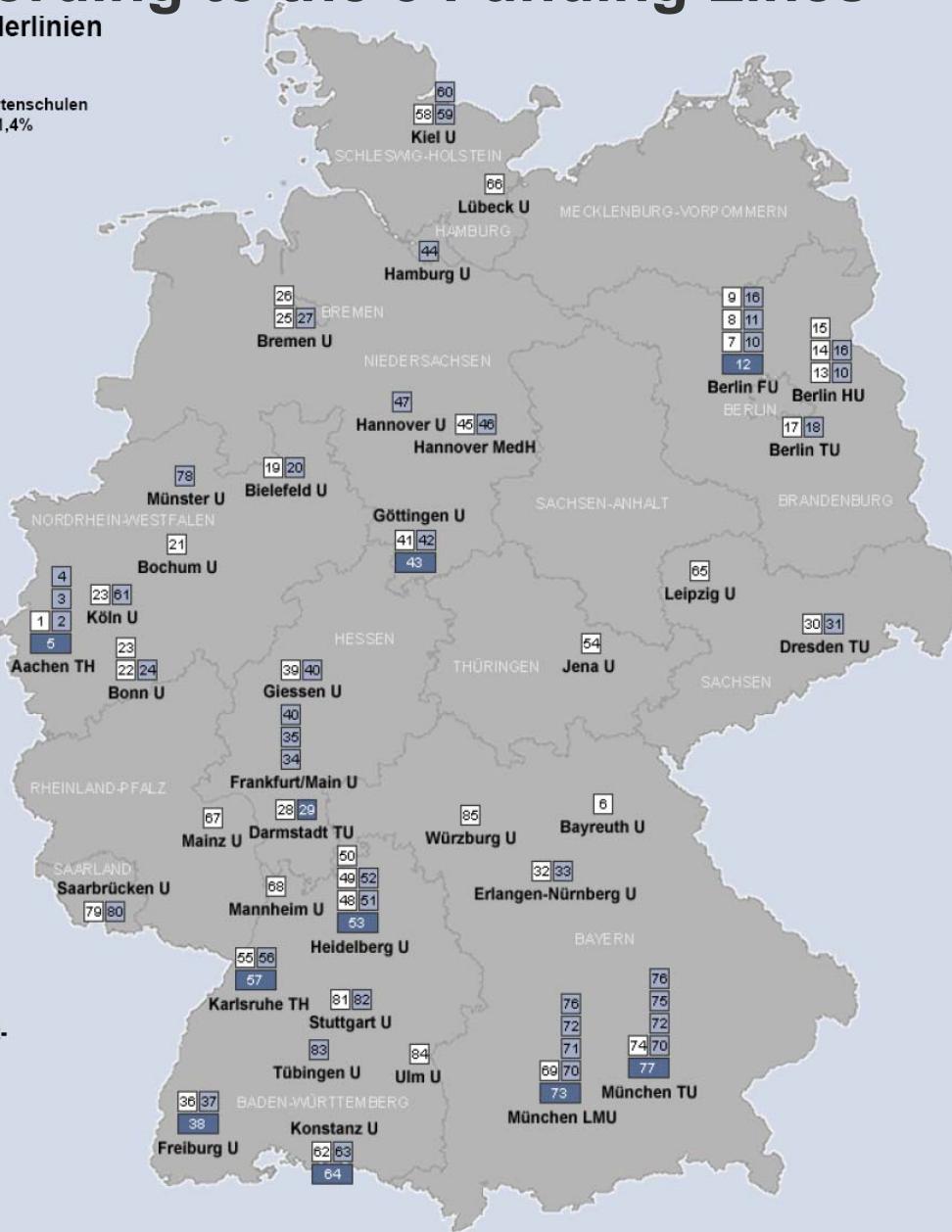
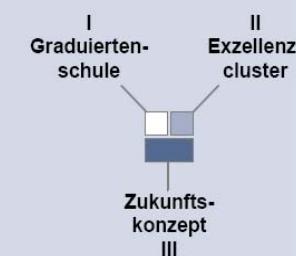
- Graduate Schools
- Excellence Custers
- Future Concepts



I. Förderlinie:  
Graduiertenschulen (GSC)  
zur Förderung des  
wissenschaftlichen  
Nachwuchses

II. Förderlinie:  
Exzellenzcluster (EXC)  
zur Förderung der  
Spitzenforschung

III. Förderlinie:  
Zukunftskonzepte (ZUK)  
zum projektbezogenen  
Ausbau der universitären  
Spitzenforschung

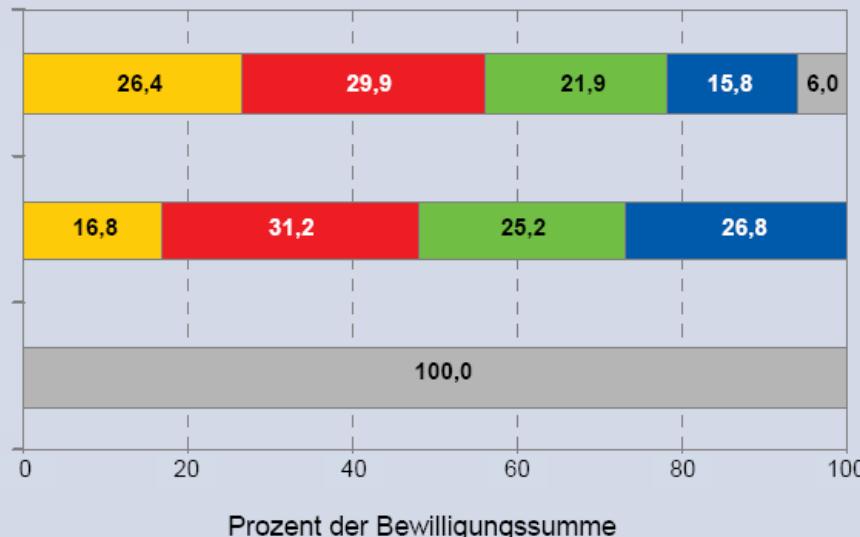


## Grants with respect to Funding Lines and Academic Sectors

### Bewilligungen nach Wissenschaftsbereichen je Förderlinie

#### Graduiertenschulen

Basis: 223,7 Mio. €  
für insg. 39 GSC



**Geistes- und Sozialwissenschaften**  
(11 GSC und 6 EXC)

**Lebenswissenschaften**  
(12 GSC und 12 EXC)

**Naturwissenschaften**  
(8 GSC und 10 EXC)

**Ingenieurwissenschaften**  
(6 GSC und 9 EXC)

**Hochschulweit**  
(2 GSC, keine EXC)

#### Exzellenzcluster

Basis: 1.179,8 Mio. €  
für insg. 37 EXC

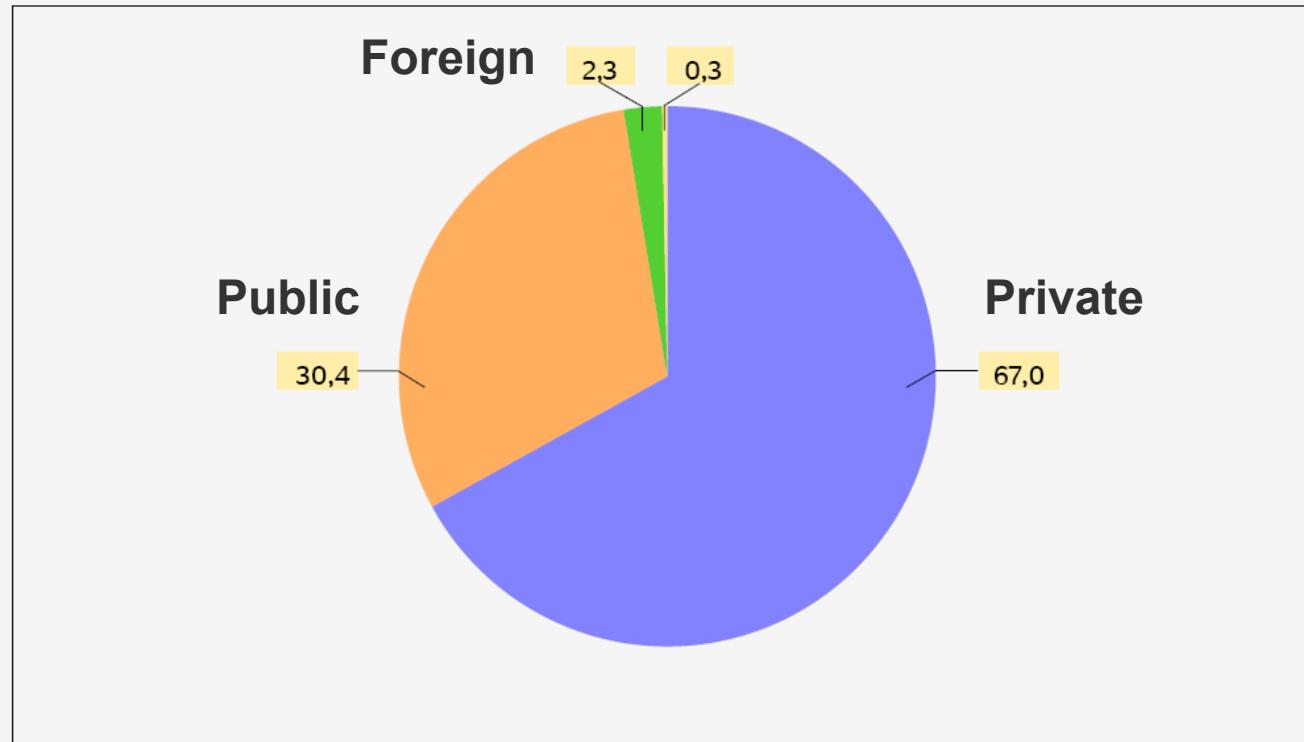
#### Zukunftsprojekte<sup>#</sup>

Basis: 565,6 Mio. €  
für insg. 9 ZUK

<sup>#</sup> Hinweis: Alle Zukunftsprojekte sind hochschulweit ausgerichtet.

### I.2 Bruttoinlandsausgaben für Forschung und Entwicklung (BAFE) der Bundesrepublik Deutschland 2004 nach Finanzierungsquellen

- Anteile in % -



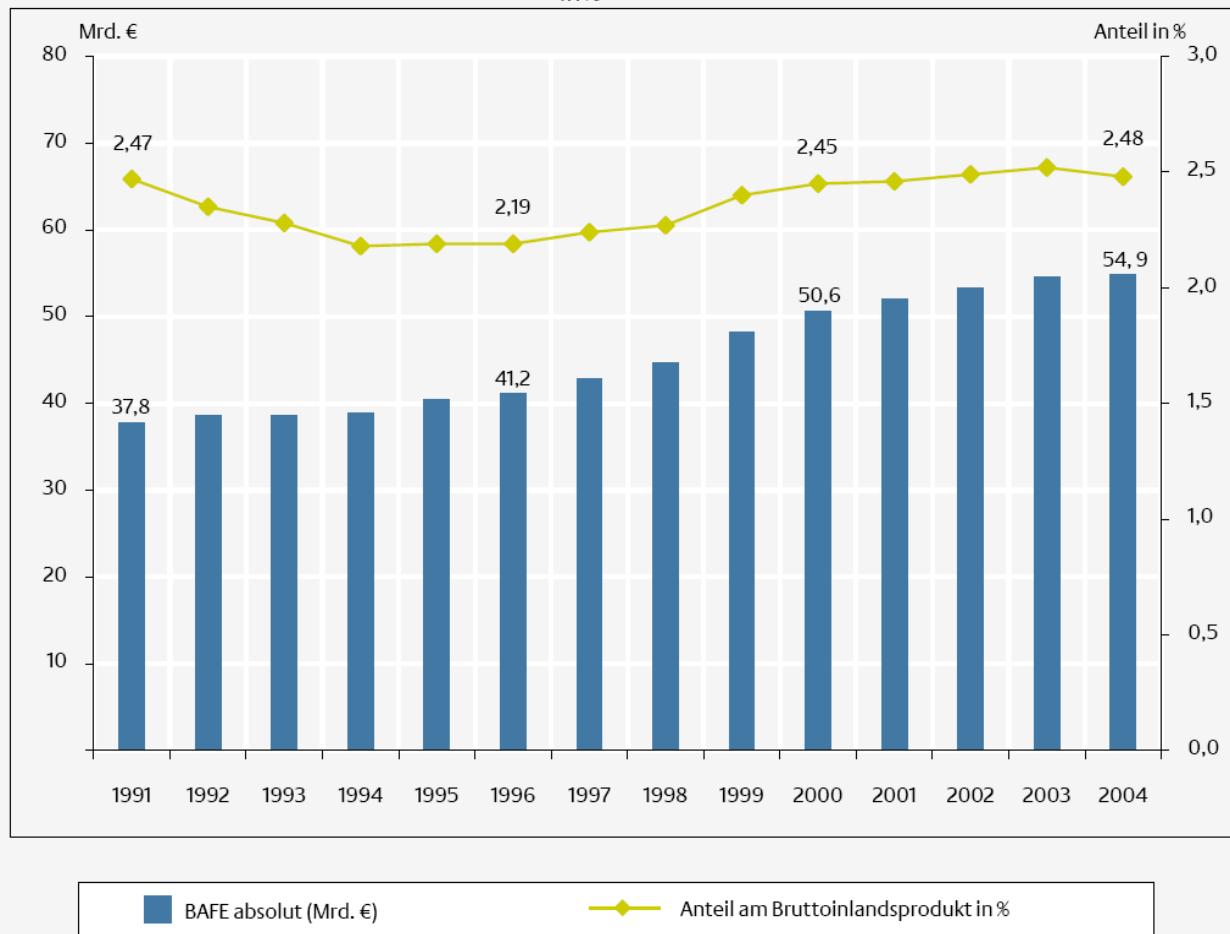
Quelle: Stifterverband Wissenschaftsstatistik, Statistisches Bundesamt und Berechnungen des Bundesministeriums für Bildung und Forschung

Percentage  
of GDP

Expenditures  
for R&D

### I.1 Bruttoinlandsausgaben für Forschung und Entwicklung (BAFE) der Bundesrepublik Deutschland absolut und als Anteil am Bruttoinlandsprodukt

- in % -



Quelle: Stifterverband Wissenschaftsstatistik, Statistisches Bundesamt und Berechnungen des Bundesministeriums für Bildung und Forschung

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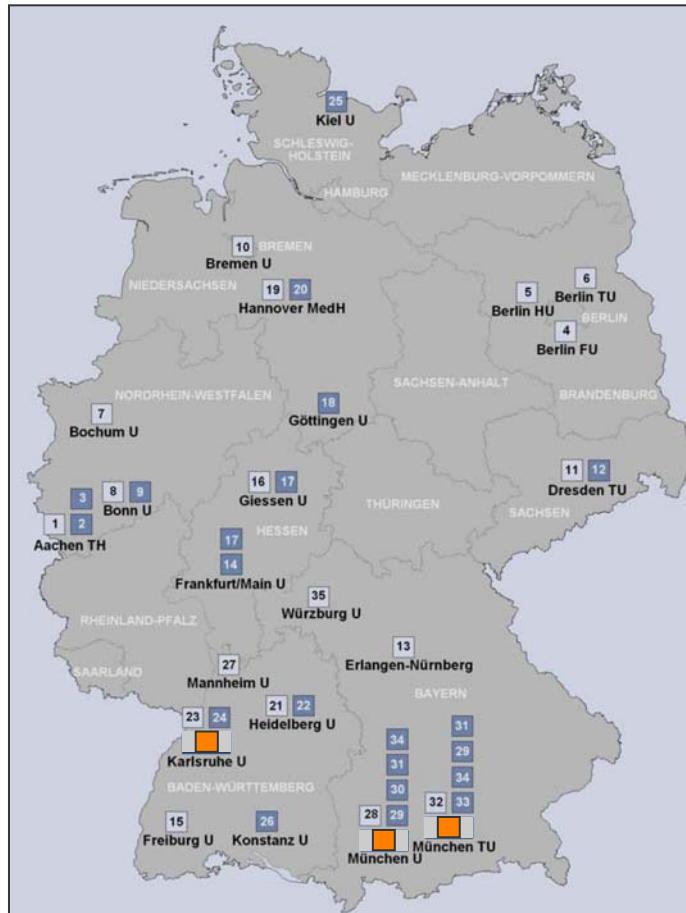
Final Remarks

TUM - The Entrepreneurial University

# 1.5 Years of Excellence Projects at the Technische Universität München

**Implementation of our Institutional Strategy  
to promote Top-Level Research**

# Munich Science Area recognized in a nationwide competition



**October 13, 2006: The successful projects of the Excellence Initiative are announced.**

**Technische Universität München involved in 8 proposals:**

- **2 Graduate Schools**
- **5 Research Clusters of Excellence**
- **Excellence University**

## Building on strong research areas to achieve Excellence

- Example: Faculties of **Electrical Engineering & Information Technology** and **Physics** leading in *Clusters of Excellence*

To be outlined later



### Cluster „**Cognition for Technical Systems**“

- Robots capable of understanding and learning
- Intelligent autopilots for vehicles and factories



### Cluster „**Origin and Structure of the Universe**“

- Fundamental understanding of time, space and matter
- Unveiling hidden properties of the cosmos

# Substantial benefits for internal cooperation and external visibility

- **Large Excellence Projects attract scientists from different fields**
  - Focus on crossdisciplinary projects in Clusters, IAS and IGSSE
  - Industry, local partner universities and research institutes participate
- **New center for corporate communication being established**
  - internal communication
  - public understanding of science
- **Excellent reputation helps expanding our worldwide network**
  - New projects with China, and also with USA, Canada, Japan, EU and South America ?



# Service for all members of our community

**Supporting research careers at all stages:**

+ finding talents, + providing excellent education, + supporting careers of young scientists, + creating excellent research environments for top-level scientists, + integrating alumni and emeriti

- **Example: High School Activities**

- Science Lab for students at Deutsches Museum:  
creating a fascination for science
- Teacher stipends: reconnecting educators  
to research
- Partner high schools



- **Example: Emeriti of Excellence**

- Active researchers receive continued support beyond official retirement (65 or 68 years)
- Experience of outstanding scientists not lost:  
Emeriti become active advisors of TUM management



## Central Projects IGSSE and IAS:

**Building the structure for the future of the Technische Universität München**



# TUM International Graduate School of Science and Engineering



IGSSE  
Kick-Off  
2007

# The Mission of IGSSE

Develop new ways of post-graduate education at TUM:

- Bridge the two cultures of science and engineering:
  - *crossdisciplinarity building on disciplinary excellence*
- Prepare young scientists for cosmopolitan leadership
  - *international recruiting & networking*
  - *research training program*
  - *gender mainstreaming measures*
- Establish the basis for the future TUM Graduate School



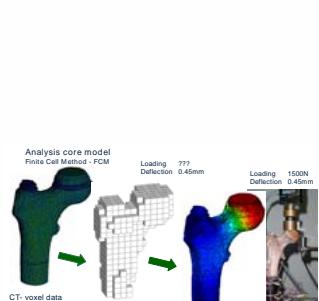
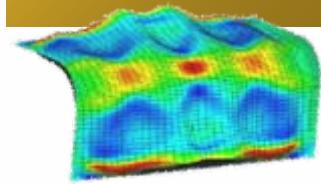
# IGSSE Research Areas

- Kick-Off in July 2007 at the TUM Study Center in Raitenhaslach
- 70 Ph.D. students team up with senior scientists, postdocs and Master's students in 20 interdisciplinary Project Teams
- 150 Ph.D. students and 30 Project Teams envisaged until mid-2008

**Computational Science & Engineering**

CeSIM  
Center for Simulation Technology in Engineering

CeCVDE  
Computational and Visual Data Exploration



## Biomedical Engineering

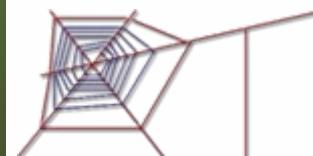
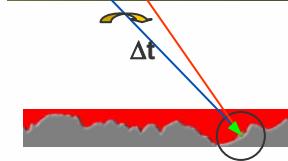
BioMedTUM  
Biomedical Microsystems Engineering



## Energy, Geodynamics & Environment

ESPACE-GS  
Earth Oriented Space Science & Technology

EnSE  
Energy Science & Engineering



## Nanotechnology & Advanced Materials

NanoCat  
Nanodesign of High Performance Catalysts

ComplInt  
Materials Science of Complex Interfaces

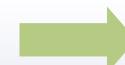


# TUM Institute for Advanced Study



## The Vision of TUM-IAS:

- Top-level scientists become IAS fellows for up to 3 years: freedom and resources to pursue innovative research  
(interdisciplinarity – high risk, high reward)
- Integration of young scholars: promoting early careers
- Inviting distinguished visiting scientists for lasting collaborations
- Focus strategy: establishing research groups in innovative hot topics



Creating a new space for starting groundbreaking research projects



# The First IAS Focus Groups

## Satellite Geomapping: Innovative approaches to measuring of climate change

### ■ Prof. Dr.-Ing. Reiner Rummel

- IAS Carl von Linde Senior Fellow 2007
- Lehrstuhl für Astronomische und Physikalische Geodäsie TUM



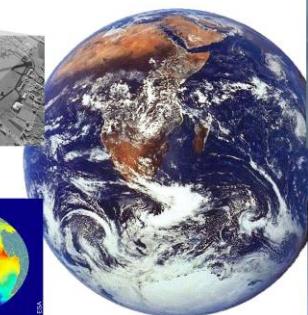
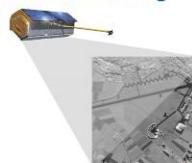
### ■ Prof. Gerhard Beutler

- IAS Hans Fischer Senior Fellow 2007
- Astronomisches Institut Universität Bern

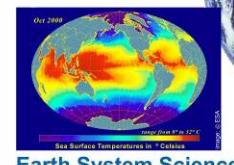
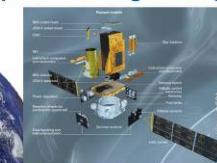
### ■ Dr. Adrian Jäggi

- IAS Hans Fischer Young Researcher 2007
- Astronomisches Institut Universität Bern

Remote Sensing



Spacecraft Engineering



Earth System Science

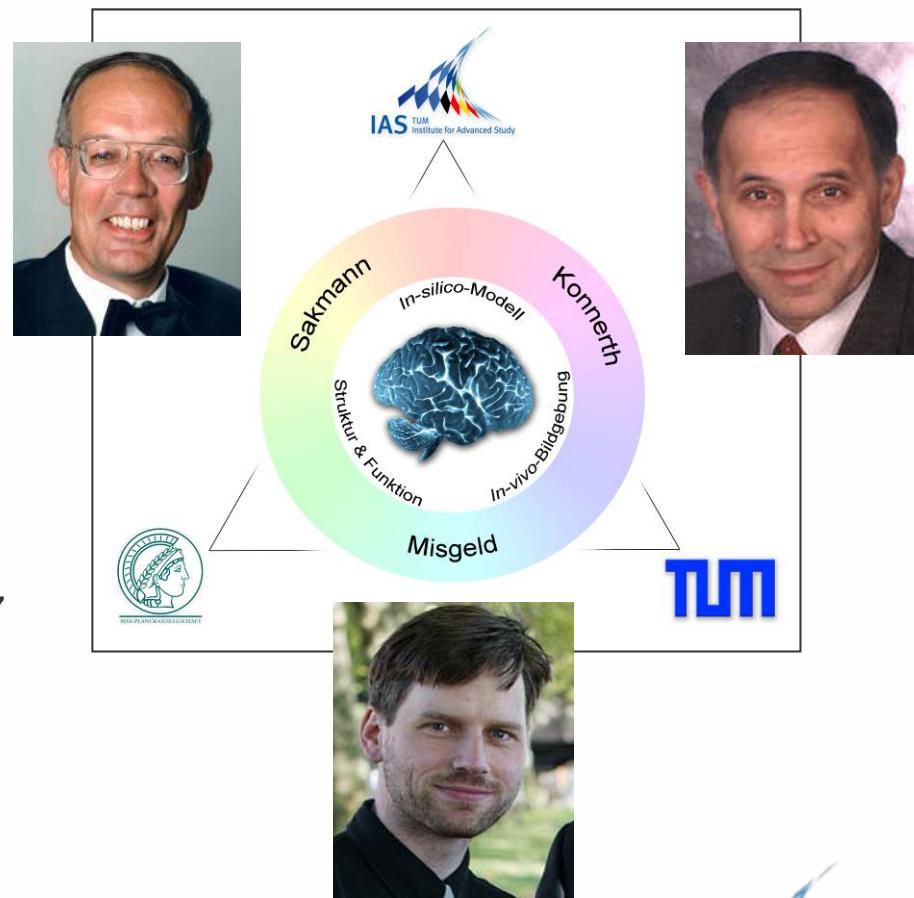
Navigation & Positioning



# The First IAS Focus Groups, cont'd

## Neurosciences: Analyzing and simulating the brain

- Prof. Dr. med. Arthur Konnerth
  - IAS Carl von Linde Senior Fellow 2007
  - Friedrich Schiedel Lehrstuhl für Neurowissenschaften TUM
- Prof. Dr. med. Bert Sakmann
  - IAS Hans Fischer Senior Fellow 2007
  - MPI für Medizinische Forschung Heidelberg
- Dr. Thomas Misgeld
  - IAS Hans Fischer Tenure Track Fellow 2007
  - Institut für Neurowissenschaften TUM



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Technische Universität München

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Stockholm Water Prize 2003  
Technische Universität München

## Planned IAS building: Heading the Garching research campus



# The Future of Excellence at TUM

## Example: Gender Issues

- More than 7 million € for new projects until 2011
- Supporting academic careers of women: specific research support programs, dual career appointments
- Family support: 2 new childcare facilities planned
- Already implemented: Parental Leave Compensation Fund, Home Offices
- Gender Research: Annual Liesel Beckmann Symposium



**LIESEL BECKMANN  
SYMPOSIUM**  
Gender in Science and Technology



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## Research Cluster

*COTESYS* : Cognition for Technical Systems



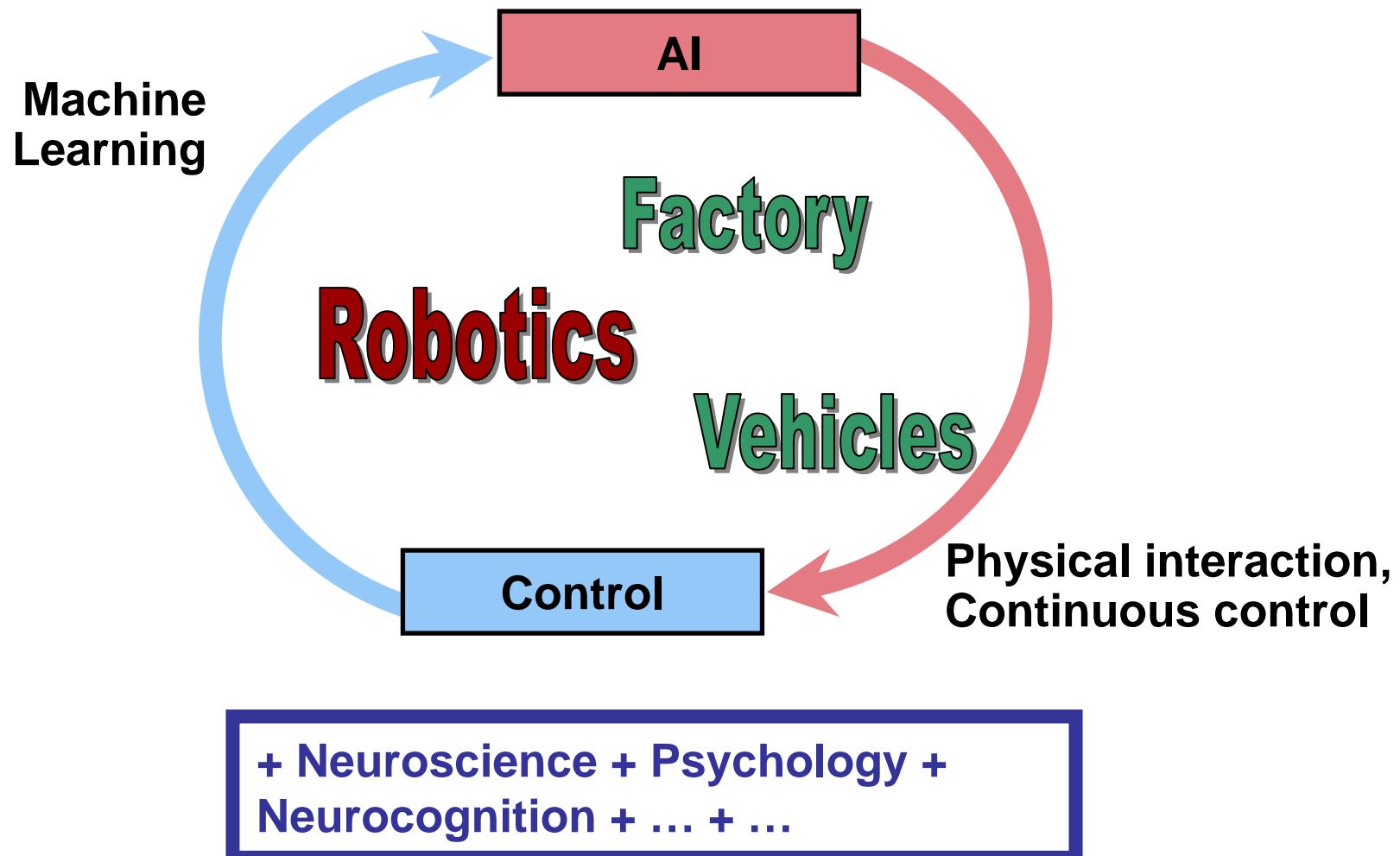
- Excellence Cluster in the framework of German *Excellence Initiative*
- 1 out of 17 national clusters established in 2006
- Unique in *Artificial Cognition and Robotics*
- Corner stone for TUM to gain status of Elite University
- Institutions involved:
  - Technische Universität München (TUM)
  - Ludwig-Maximilians Universität München (LMU)
  - Universität der Bundeswehr (UBW)
  - German Aerospace Center (DLR)
  - Max-Planck Institute for Neurobiology (MPI)
- 30 PIs, approx. 80 researchers (doctoral/PostDoc)
- Sustainable impact on university structure and research infrastructure



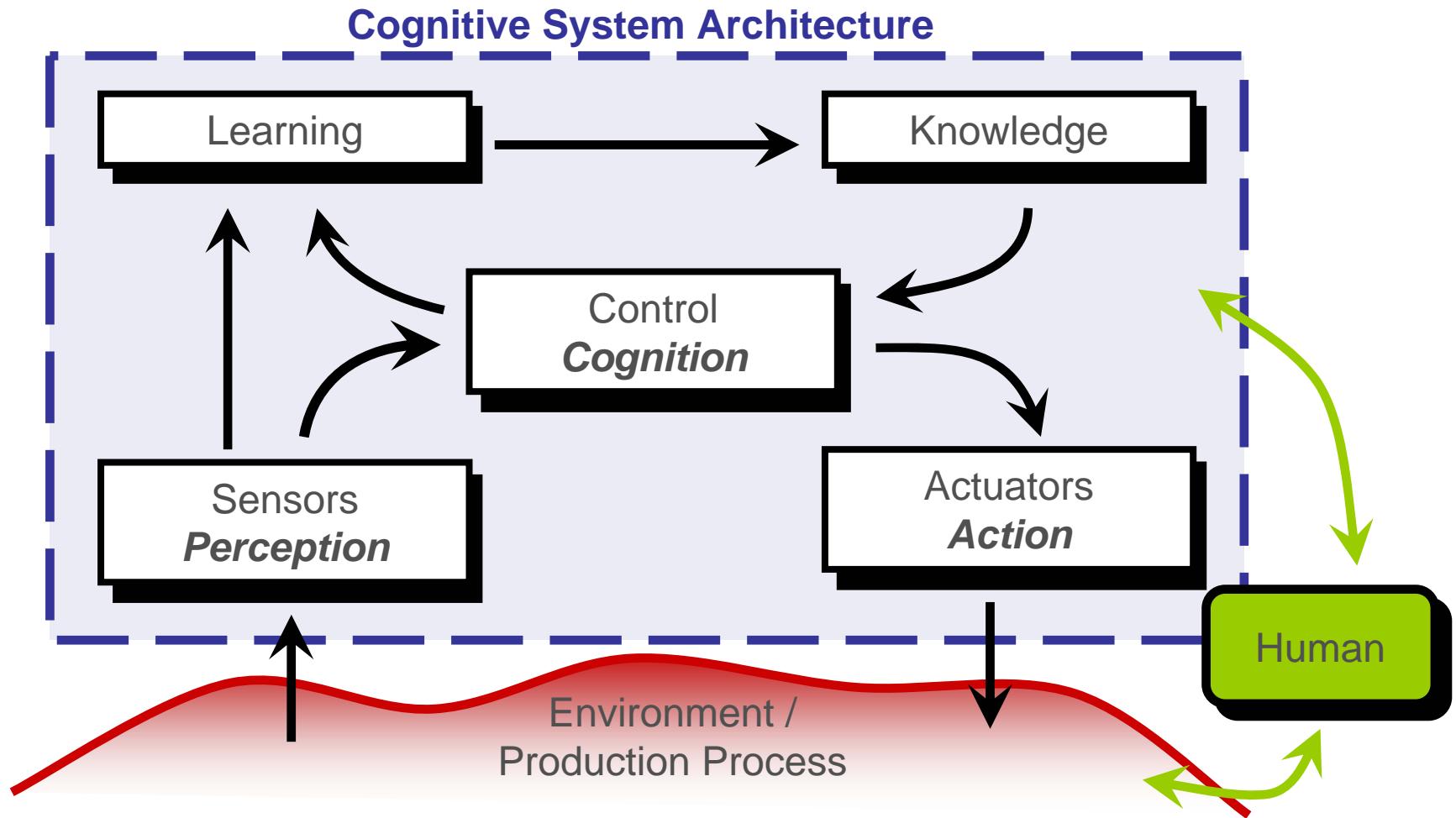
Max Planck Institute  
of Neurobiology



# Artificial Cognition meets Control

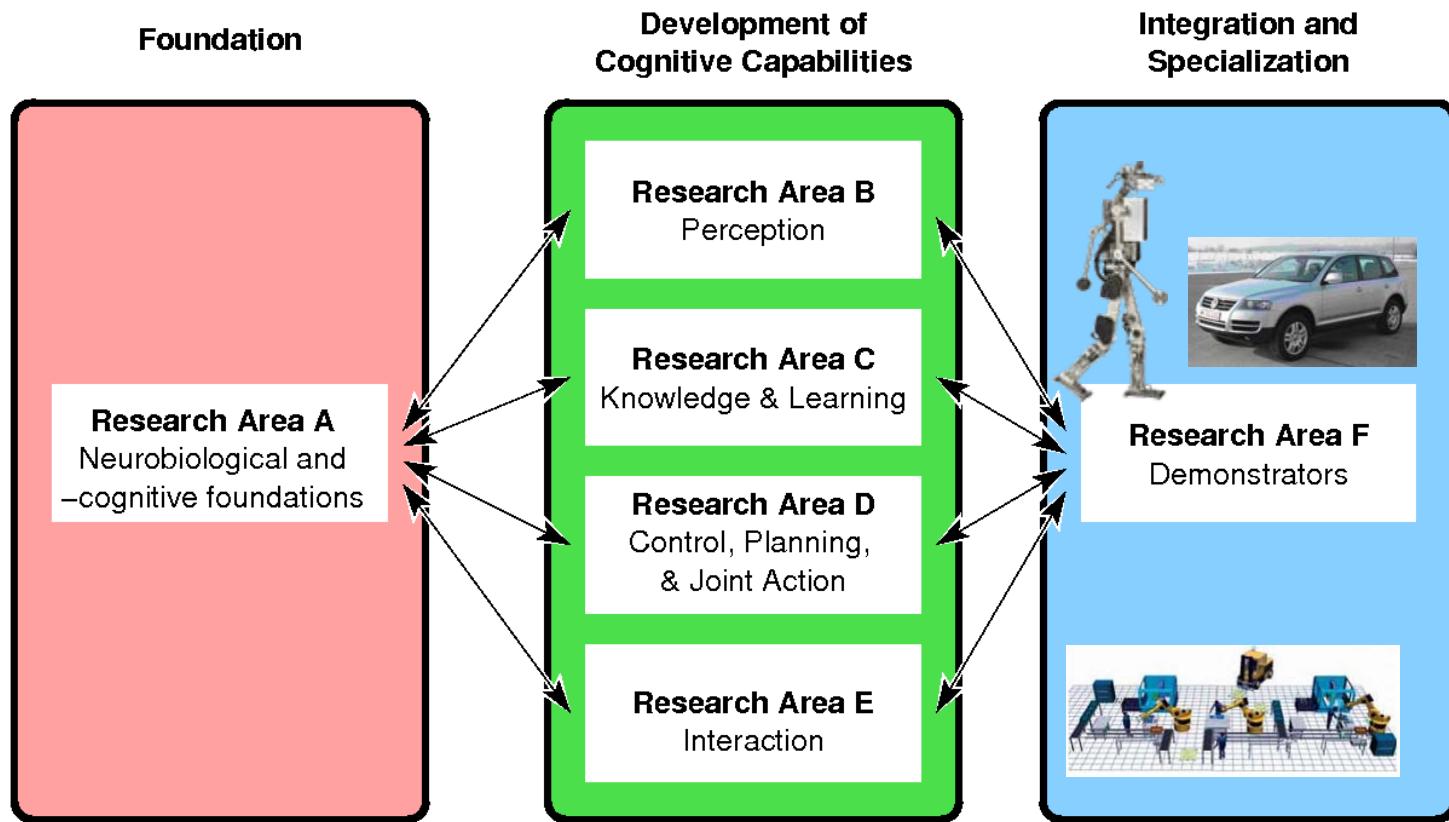


# Perception-Cognition-Action Loop



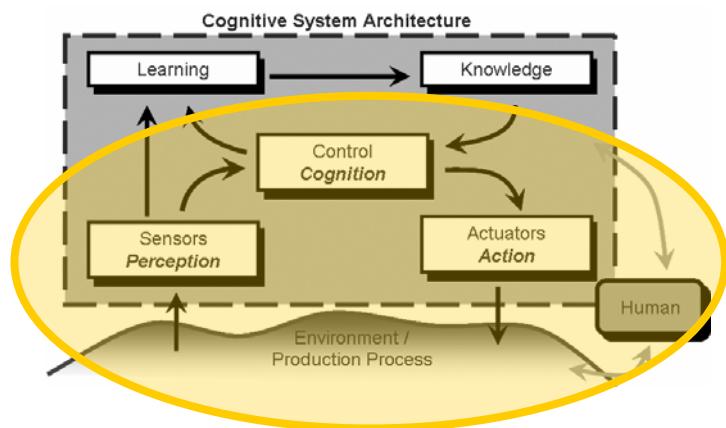
# Unique Research Profile

- Focus on full-scale technical systems
- All relevant disciplines involved

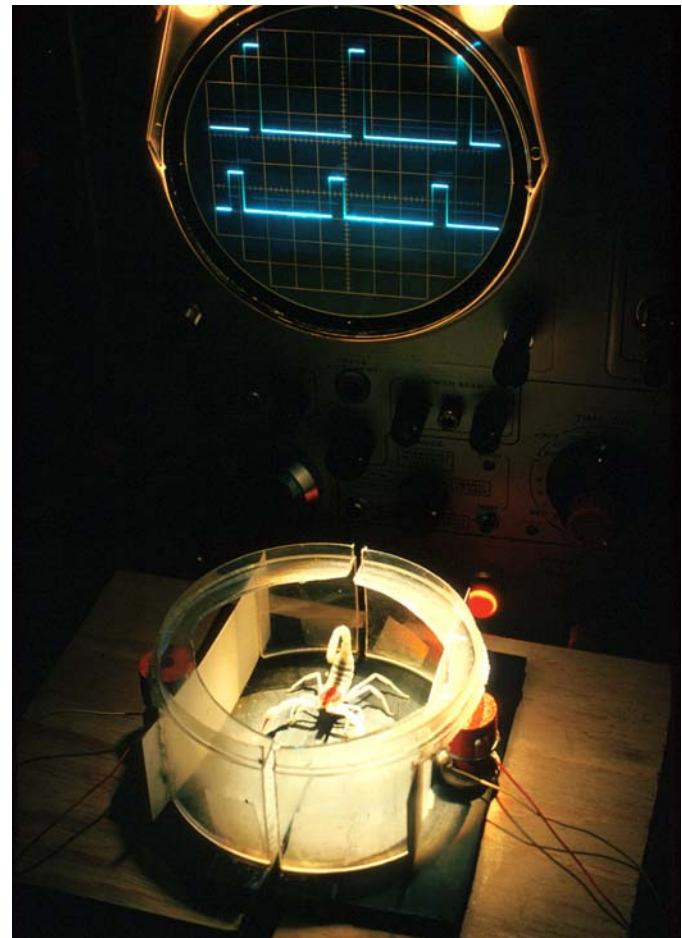


# RA-A: Neurobiological Foundations

- Perception-Motor-Action Coupling
- Spatio-Temporal Perception
- Selective Attention
- Learning

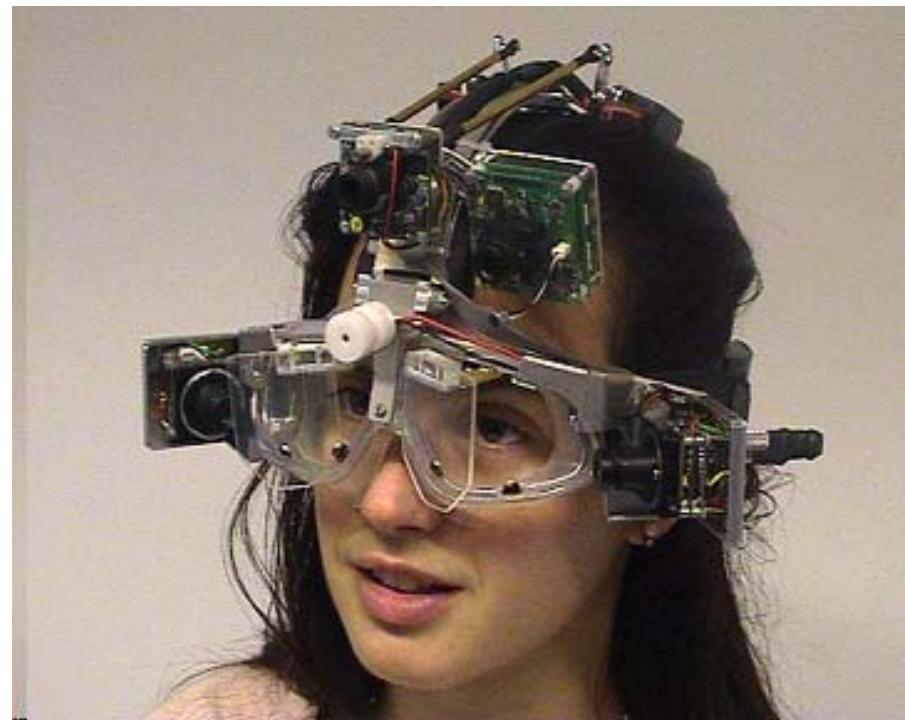
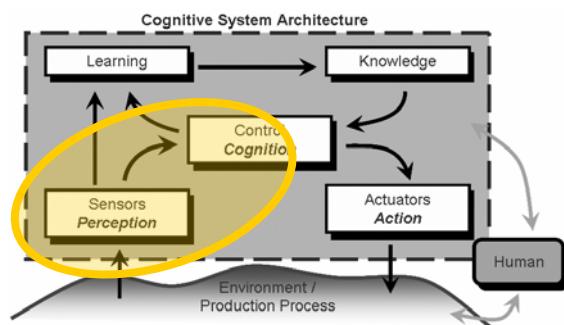


*Explore principles  
of biological cognition*



# RA-B: Perception and Model Acquisition

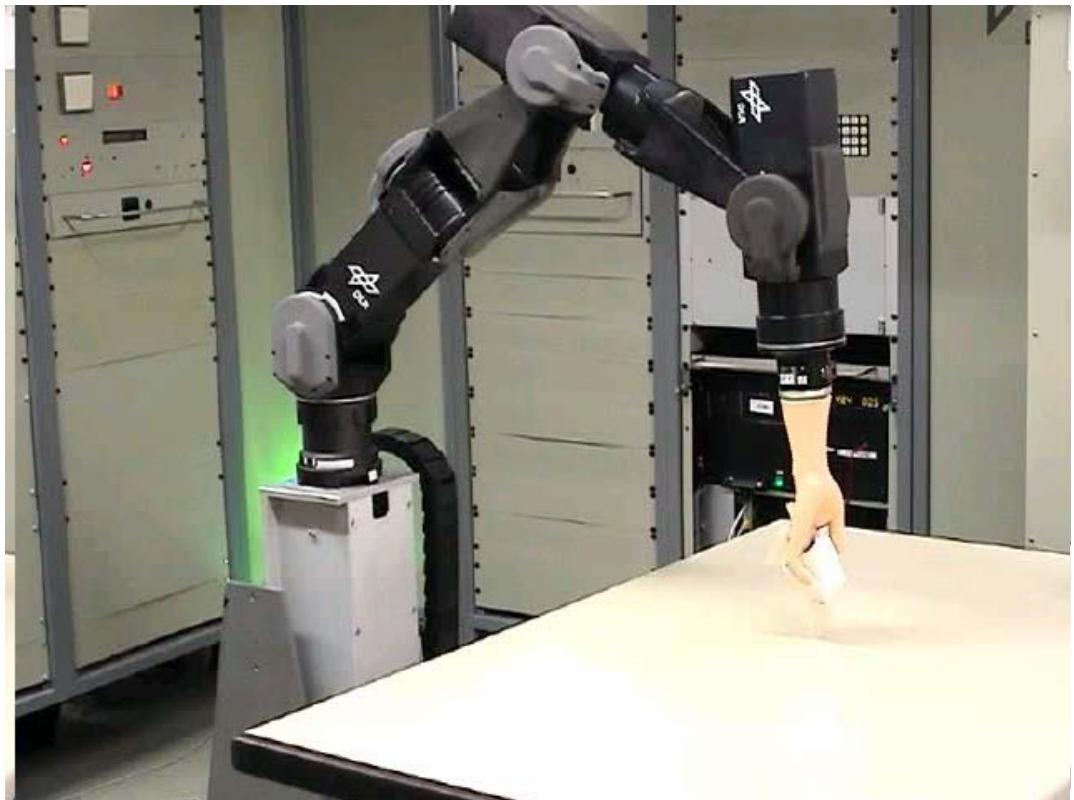
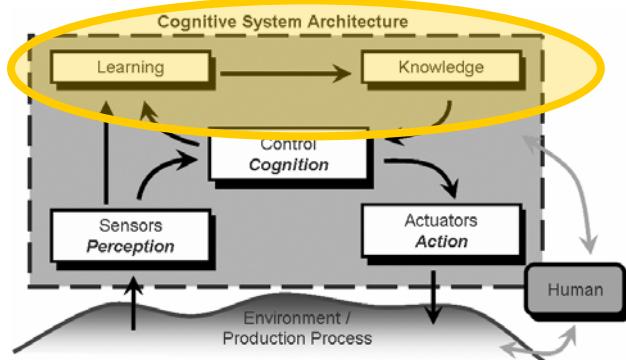
- Multisensory Perception
- Environment Modeling
- System Analysis and Diagnosis
- Cognitive Perception for Action



***Perceive and understand the environment***

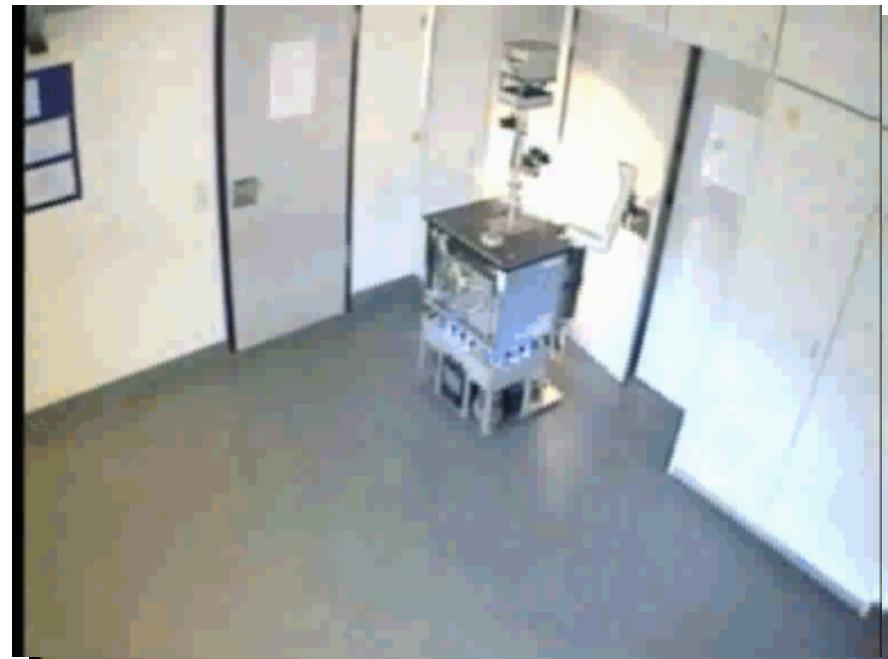
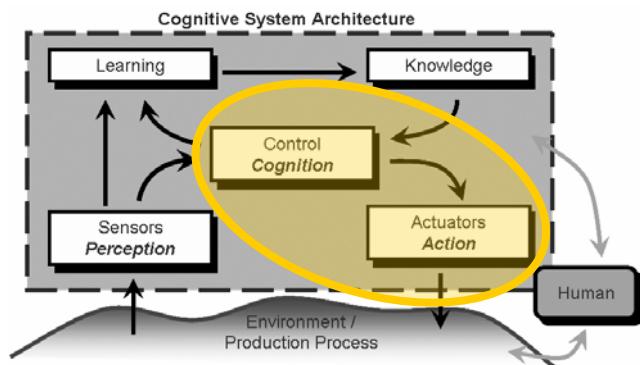
# RA-C: Learning and Knowledge

- Action-Aware Control
- Sequence Learning
- Embedded Learning Architecture
- Probabilistic Framework



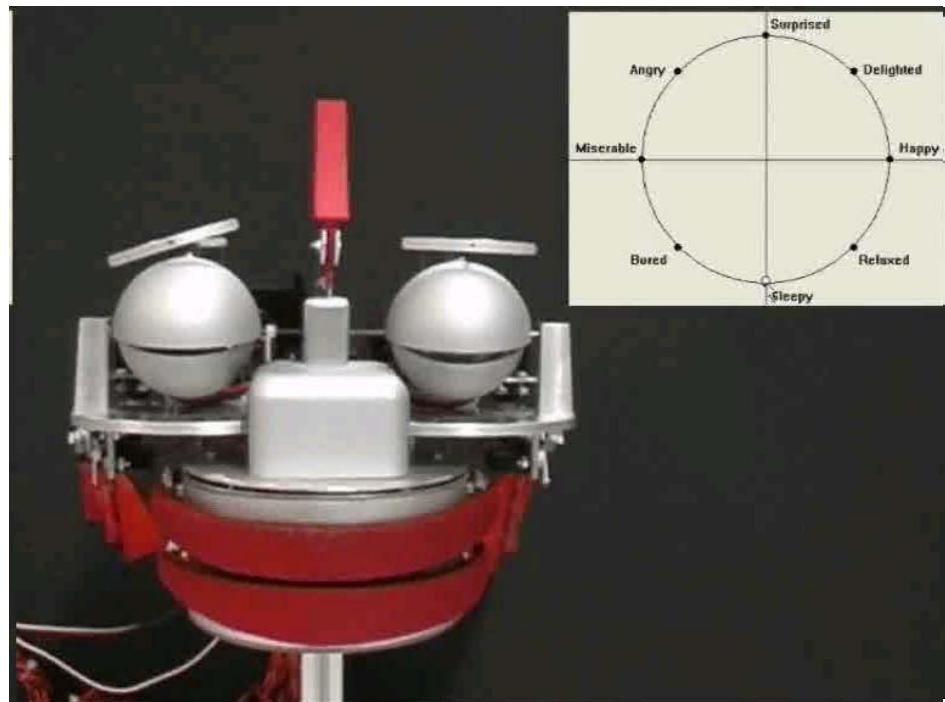
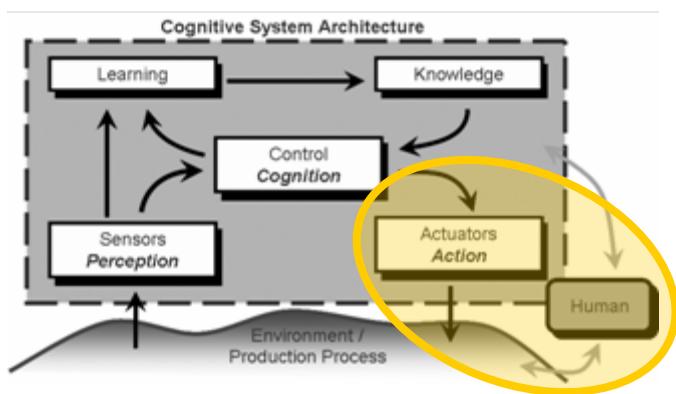
***Learn and enhance skills through experience***

- Mathematical Foundations
- Action Selection Mechanisms
- Plan-Based Control
- Joint Action



***Act independently on the own initiative***

- User Interface and Dialogues
- Advanced In/Output Technology
- Emotion, Action, and Intention
- User Modeling



***Communicate on human terms***

# RA-F: Cognitive Vehicles

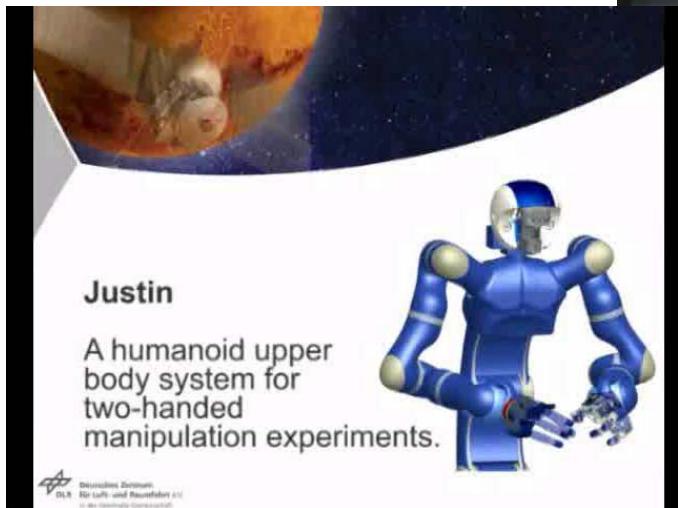
- Offroad/urban Land Vehicle
- Cognitive Aerial Vehicle
- Emotion, Action, and Intention



***Cooperate with other cognitive systems***

# RA-F: Cognitive Humanoid Robot

- Shopping
- Kitchen
- Robot butler
- Service robot

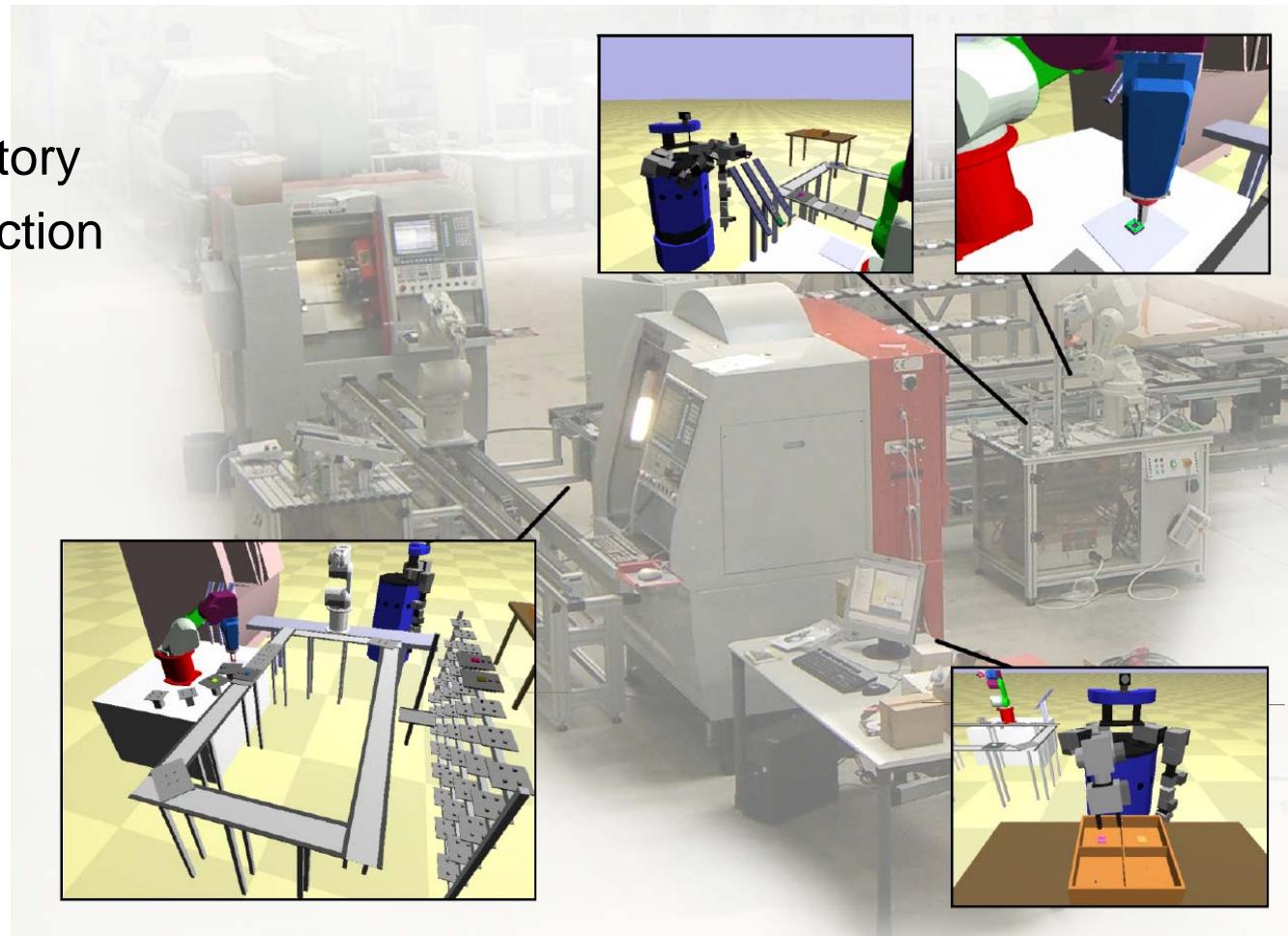


***Universal assistance  
in everyday life tasks***



# RA-F: Cognitive Factory

- Self-Aware Factory
- Adaptive Production Planning
- Robot-Worker Integration



***Collaboration and cooperative problem solving***

# Major Research Goals

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- Capabilities within Cognitive Technical Systems:
  - Plan, reason, explain and reflect
  - Learn and adapt – reliable and flexible
  - High human interactivity – joint action and cooperation
  - Self- and environment-awareness
  - Respond robustly to surprise and exception



**Interface between complexity of technical environment  
and unique human way of thinking**

**Adaption of machines to humans**

# The 'Excellence Initiative' and the Restructuring of German Universities

Introductory Remarks

The TUM Approach

Research Cluster *CoTeSys*

Final Remarks

- E-Initiative stimulates **productive powers** in the academic community
- Equalization replaced by **Competition**
- Attracts extra **sponsoring** by national and international enterprises
- Strive to enter the **Top 10** of international rankings
- Elite Universities depend on **top human resources**
- Attractiveness to talented international students, researchers and scholars
- Excellence in Teaching: currently 50 : 1 student / teacher ratio
- Research- and / or Education-oriented universities ?
- Transfer of inventions into innovations: patents, business plan, start-ups etc.
- Shake-out of Elite University candidates after 5 years from 9 to 3 ?

*See you  
at the*  
**Technische Hochschule München**

