1 The Topic
Knowledge-based Systems for Industrial Applications

- Product Life Cycle

(Re-)Design

- Recycling
- Manufacturing

- Maintenance
- Control
Design - Tasks


Recycling

Manufacturing

Maintenance

Control

Control Generation/Verification
Manufacturing, Assembly - Tasks

- Design
- Recycling
- Maintenance
- Control
- Manufacturing
  - Production Planning, Scheduling
  - Quality Control, Testing
Monitoring, Control - Tasks

Design

Recycling

Manufacturing

Maintenance

(Control)

Fault Detection/Identification

Training

Control Generation/Verification

(Self-) Reconfiguration, Recovery
Recycling - Tasks

- Re-Manufacturing
- Disassembly
- Recycling
- Testing
- Repair

- Design
- Manufacturing

- Maintenance
- Control
Knowledge-based Systems for Industrial Applications

Basis for problem solving:
- Knowledge about technologies

(Re-)Design

Recycling

Manufacturing

Maintenance

Control

- Function
- Components
- Processes
- Materials

- Production processes
- Disturbances
- Faults
- ...

- Design
- Manufacturing
- Control
- Maintenance
- Recycling
Knowledge-based Systems

- Systems based on knowledge

but
- Systems grounding their solution on a knowledge base
Knowledge Base and Problem Solver

**Problem solver:**
- A usually **task-specific**,  
- possibly **domain-independent**  
- algorithm which can process the represented knowledge

**Knowledge base:**
- an **explicit**  
- **declarative**  
- **formal** representation  
- of knowledge about a certain domain and/or class of tasks
Knowledge Base and Problem Solver: „What“ and „How“

Separate:
- How (a certain class of problems is solved)
- What (is the individual problem to be solved?)

Advantages:
- Transparent, maintainable, extensible solution
- Re-use of (parts of) knowledge base and problem solver
For Instance: Diagnosis

Observations:

ü "When braking with ABS, car is yawing to the right, and brake pedal feels harder than normally”

ü "Yawing”:
  – under-braking at left side
  – over-braking at right side
Diagnose: „Was“ und „Wie“

Wissen über den Gegenstand
- „Wie ist der ABS aufgebaut?“
- „Wie funktioniert der ABS?“

Wissen über
- Struktur
- Komponentenverhalten

Diagnose-Algorithmus
- Aus Wissen über den Gegenstand
- und Beobachtungen des Systemverhaltens
- ableiten diagnostische Hypothesen
Transfer to Industrial Applications

For instance:
Vehicle
On-Board-Diagnosis
Volvo test vehicle with model-based On-board diagnosis
Model-based On-board Diagnosis Demonstrator

For instance:
Model-based Diagnosis

ü Flashed onto control unit of a VW Polo comfort system
Other Application Examples

- NASA: model-based self-diagnosis and reconfiguration (Deep Space 1)
- MITA: Copier with auto-correction
- Ford: automatic Failure-Modes-and-Effects Analysis (FMEA) of electronic circuits
- Xerox: automatic generation of copier-control software
- ...

...
Lecture

Application system
- Failure-modes-and-effects analysis
- Diagnosis
- Test Generation
- ...

Methods and Techniques for knowledge-based Systems
- Modeling
- Constraint Satisfaction
- (Truth Maintenance)
- Automatic diagnosis
- ....

Examples
- “Exercises”
- Demonstrations
Material

- Slides as pdf in the Web
  http://wwwradig.in.tum.de/research/MQM/teaching/KBSIA/Material.php
  (announced via e-mail)
- Script for the main part (model-based problem solving)
- Papers for individual chapters
- In case of problems:
  e-mail to
  Yichen Mao <maoy@in.tum.de>

Questions?