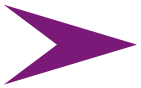
Model-based Diagnosis
Tutorial PHM-E 12

Peter Struss
Tech. Univ. of Munich
Univ. College Cork
OCC'M Software GmbH
struss@in.tum.de

© OCC'M Software

Outline



1 Introduction: Model-based Systems
2 Component-oriented (Qualitative) Modeling
3 Consistency-based Diagnosis
(4 Test Generation)
5 Other Tasks during the Product Lifecycle
6 Summary and Perspectives

Knowledge-based Systems

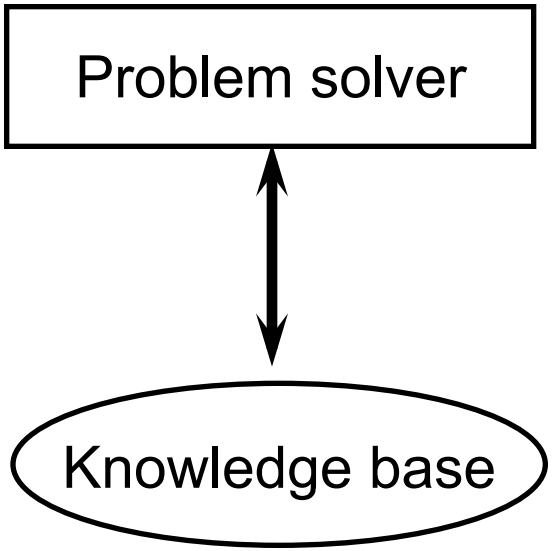
- Model-based systems are knowledge-based systems

are not simply

- Systems based on knowledge

but

- Systems grounding their solution on a knowledge base



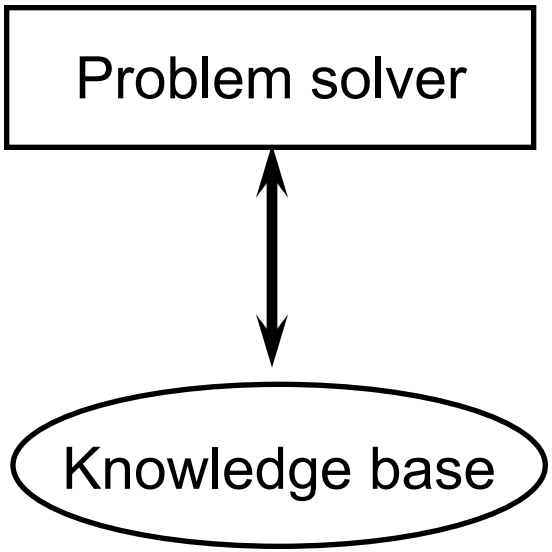
Knowledge Base and Problem Solver

Provlem solver:

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

Knowledge base:

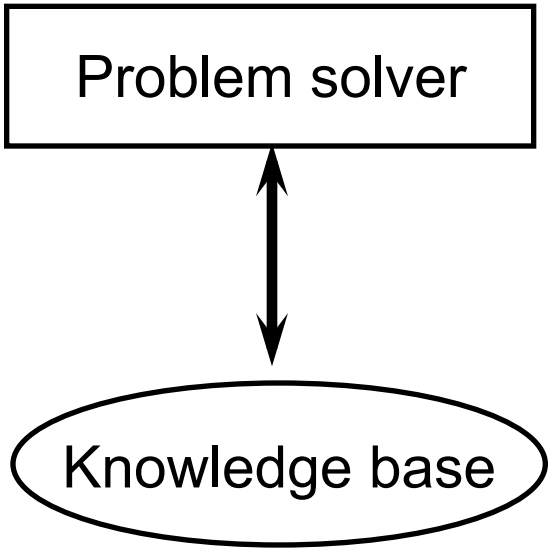
- an explicit
- declarative
- formal representation
- of knoweldge about a certain domain and/or class of tasks



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)

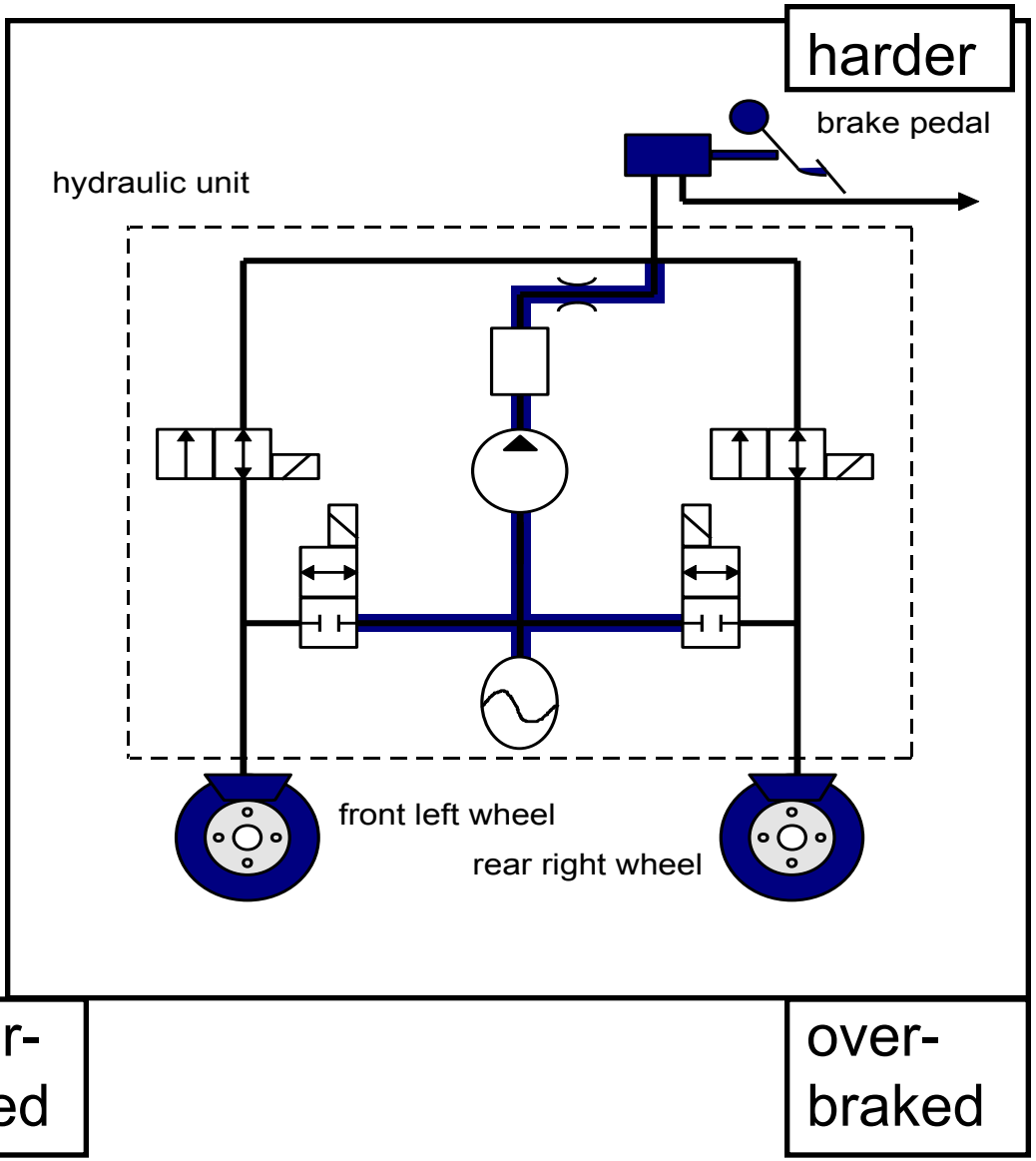
Advantages:

- Transparent, maintanable, extensible solution
- Re-use of (parts of) knowledge base and problem solver

For instance: diagnosis

Observations:

- "When braking with ABS, car is yawing to the right, and brake pedal feels harder than normally"
- "Yawing":
  - under-braking at left side
  - over-braking at right side



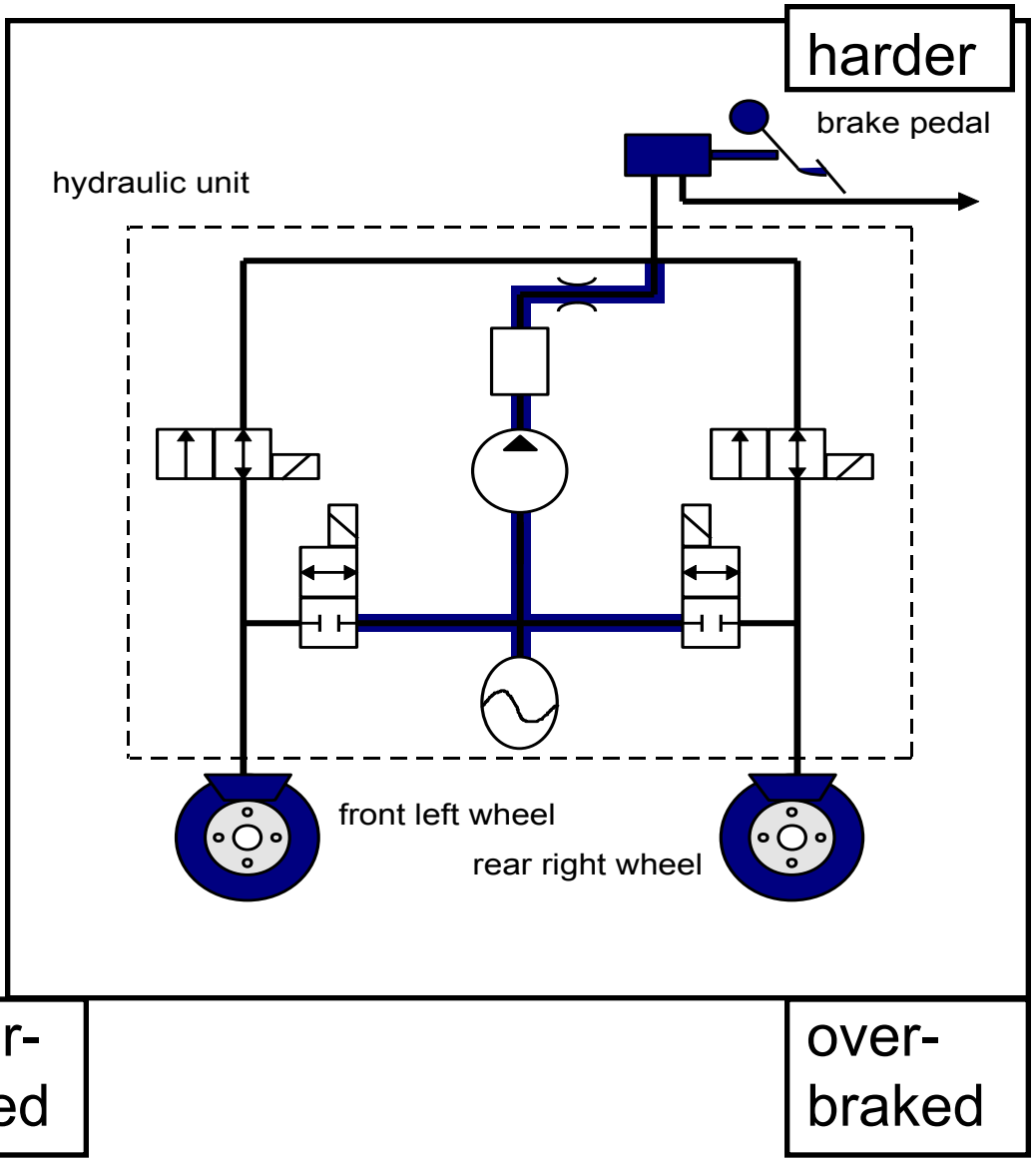
Diagnosis: „What“ and „How“

Knowledge about the subject

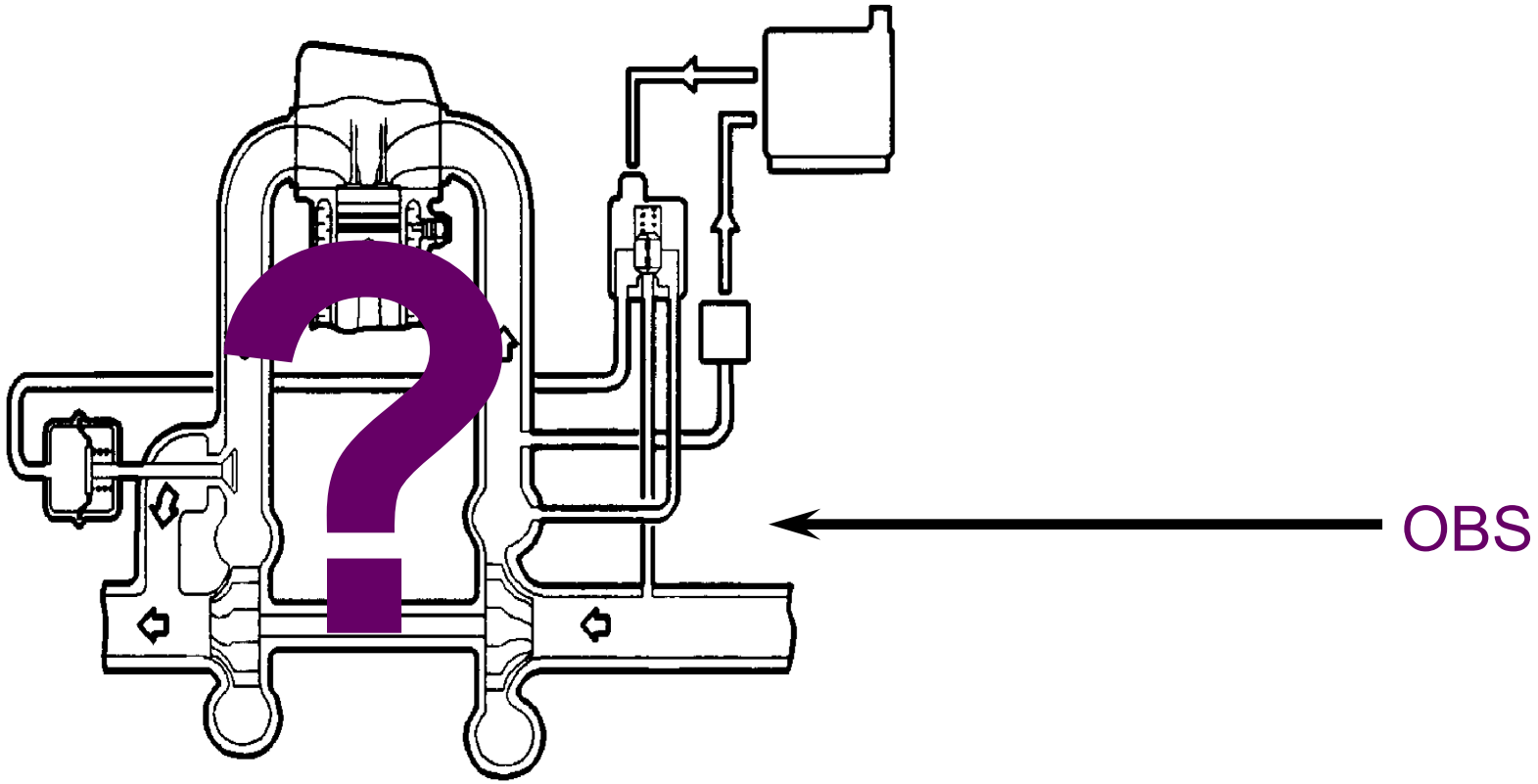
- „How is it structured?”
- “How does it work?”
- Knowledge about
  - Structure
  - Componenten behavior

Diagnosis Algorithm

- From knowledge about the subject
- and observations of the system behavior
- infer diagnosis hypotheses



Diagnosis



Task:

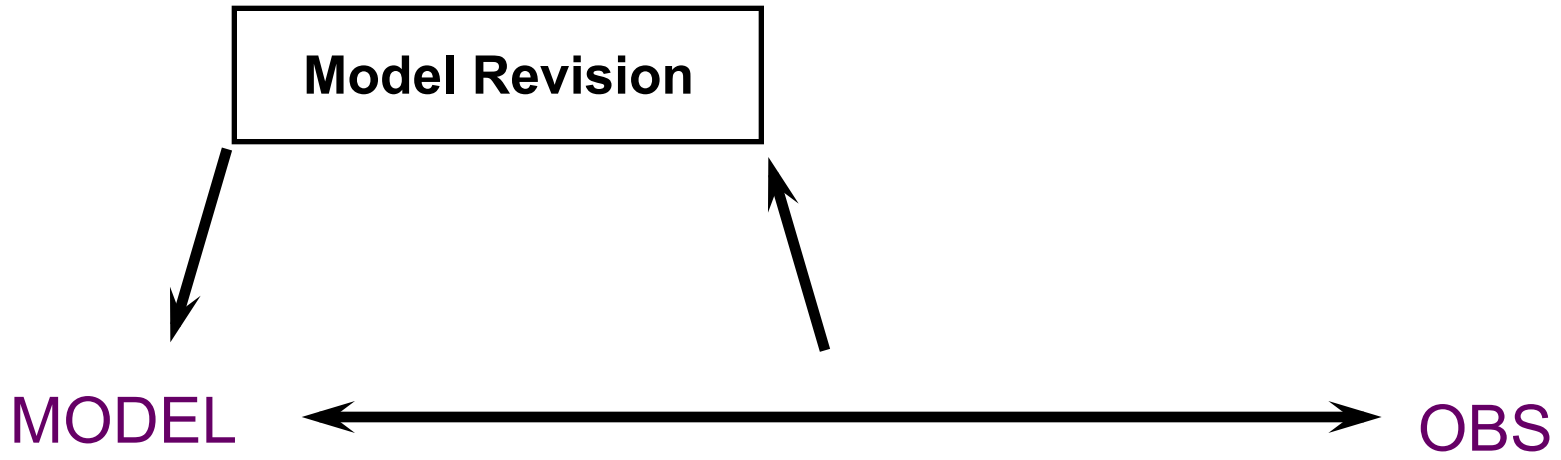
- Determine, based on a set of observations:
- What`s going on in the system?

Model-based Diagnosis

Task:

- Determine system models
- that are consistent with the observations

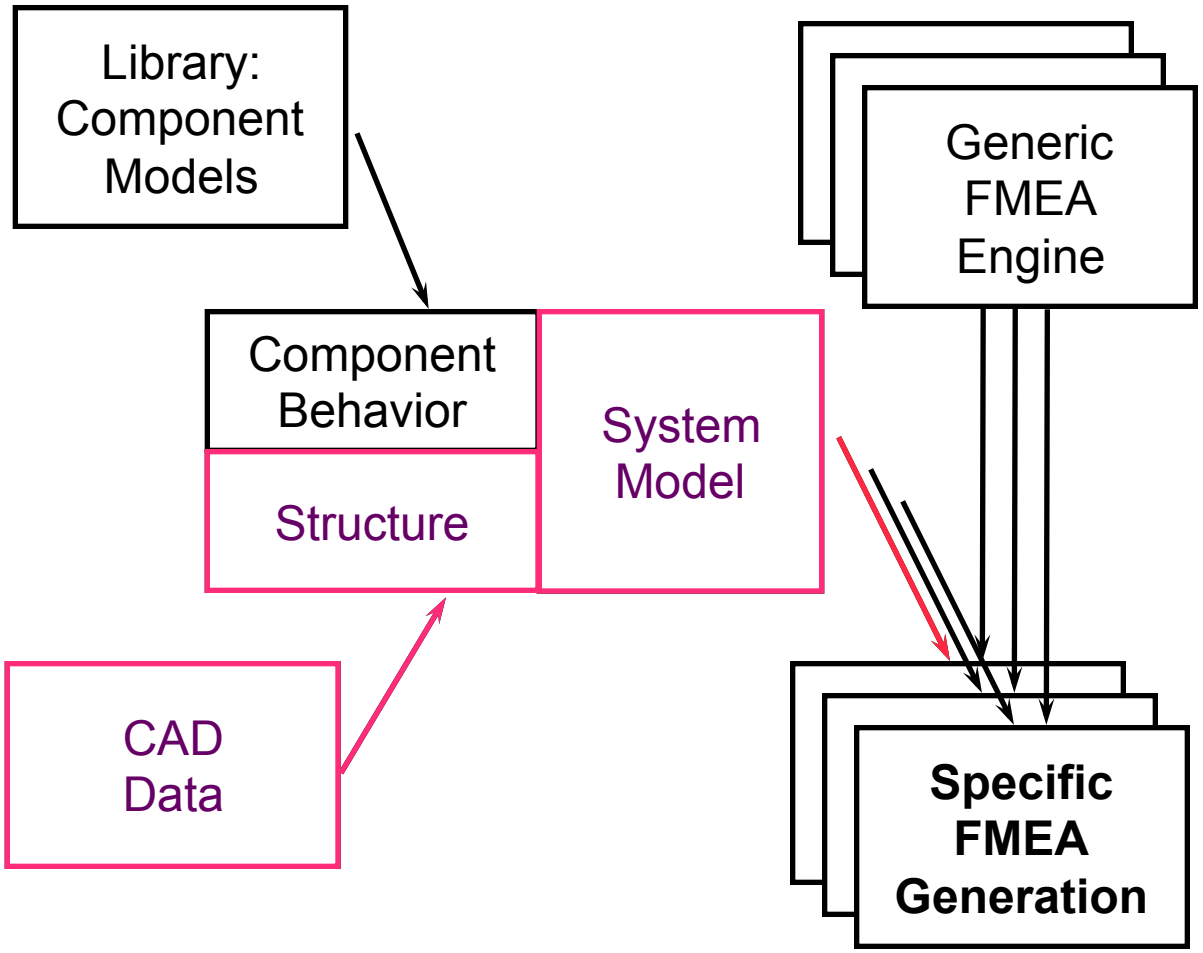
Iterative Diagnosis



Task:

- Incremental modification of fault hypotheses
- Initial hypothesis: correctly designed device

Key Idea: Generation of Diagnosis Systems



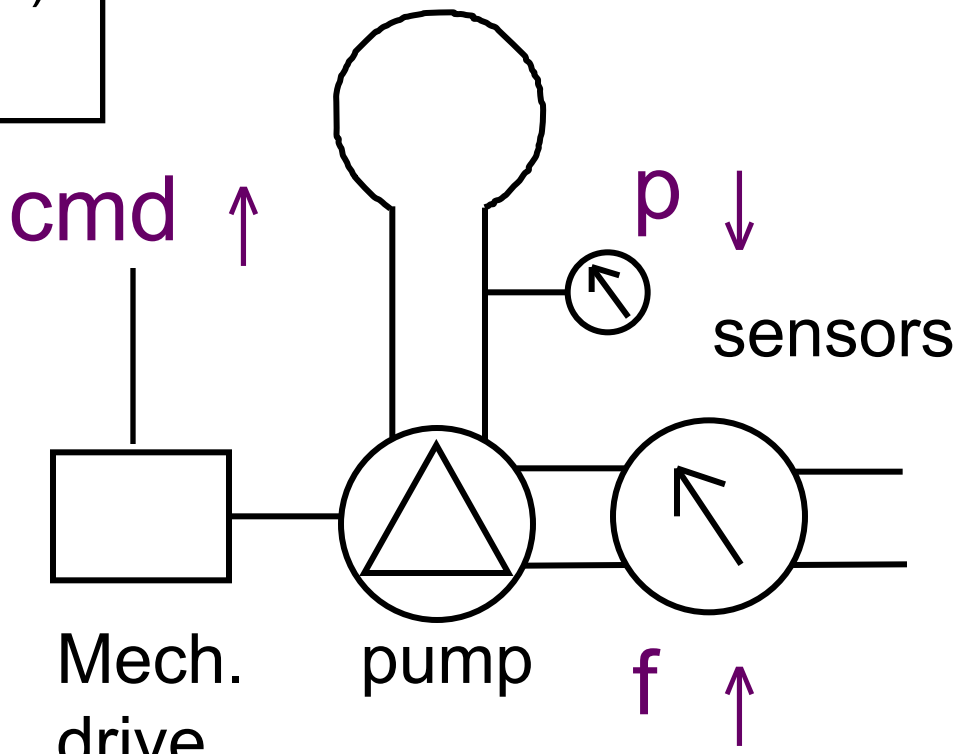
- User: specifies structure only
- Diagnosis system is generated automatically

- The same for FMEA, Testing, ...

Generic Diagnosis Algorithm?! - Simple Example

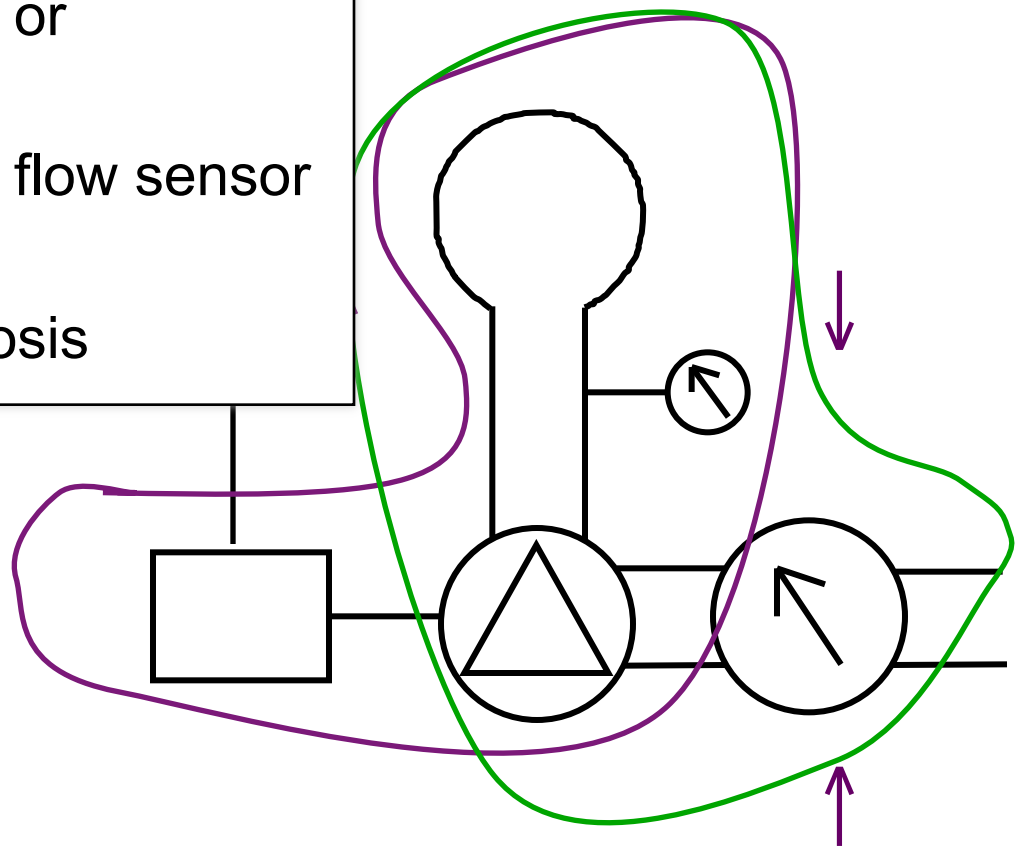
Models

- explicit conceptual and structural model
- Behavior models
- Compositional („context-free“)
- (possibly) qualitative models



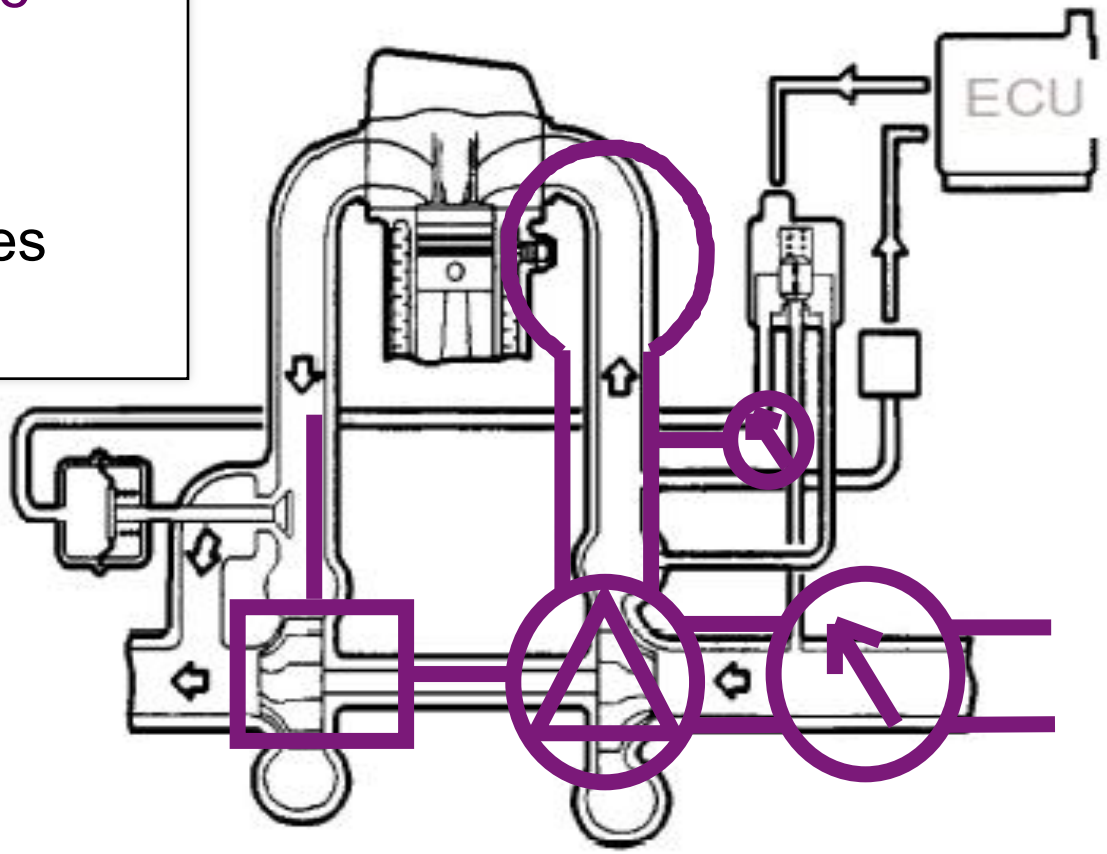
Simple Example – Diagnostic Reasoning

- Inconsistent partial models: „conflict“
- combined evidence from several conflicts
- Pump or pressure sensor or container defect
- OR mechanical drive and flow sensor
- logical theory:
  consistency-based diagnosis



Demonstrator: Turbo Charger System

- On-board detection and localization of
- faults related to black smoke
- under realistic conditions (e.g. sensors)
- with model-based techniques from Artificial Intelligence



Project Vehicle Model Based Diagnosis (2/97-1/99)

GenRad

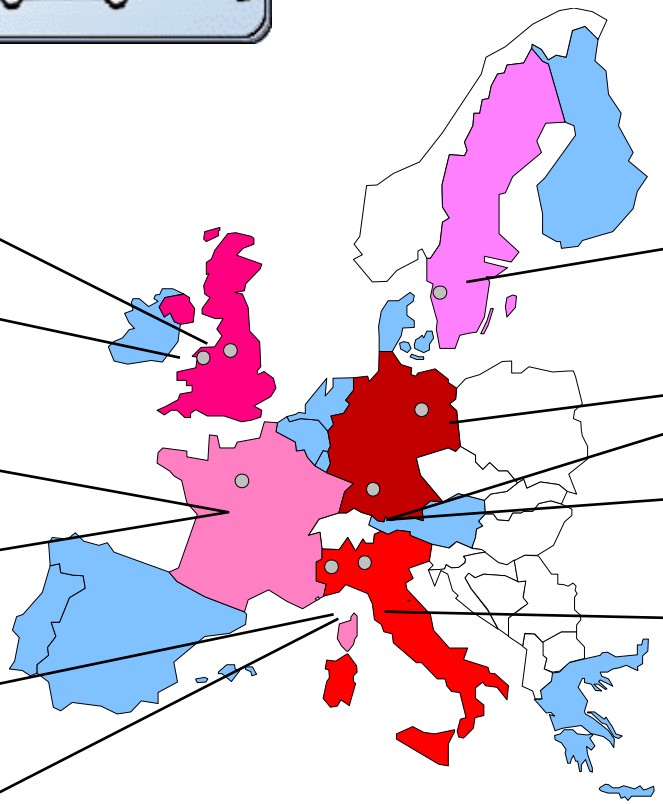
Prifysgol Cymru
Aberystwyth
The University of Wales

UNIVERSITE 13
PARIS NORD

DASSAULT ELECTRONIQUE

CENTRO RICERCHE FIAT

Università degli Studi di Torino

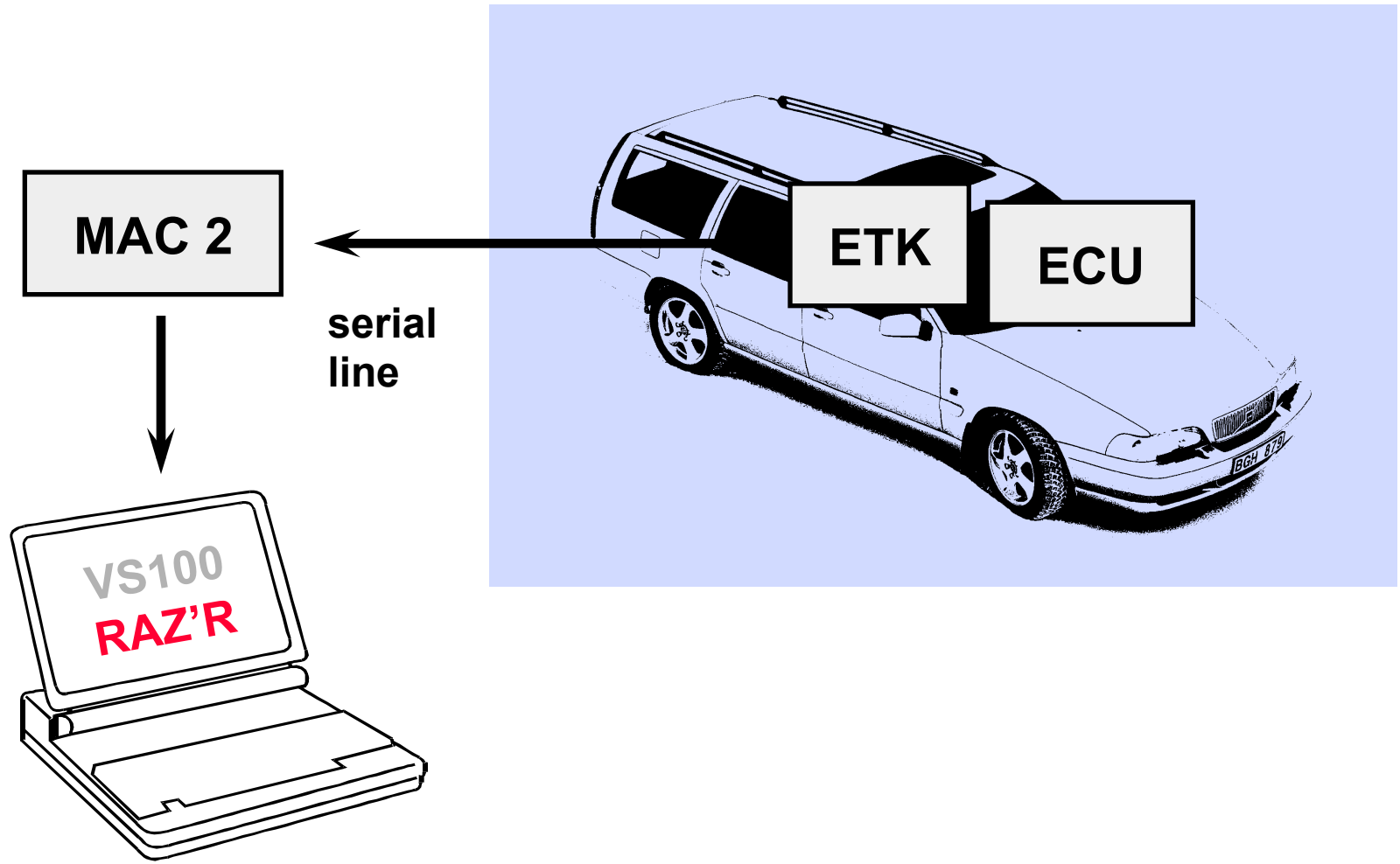


VOLVO

BOSCH

MAGNETI MARELLI

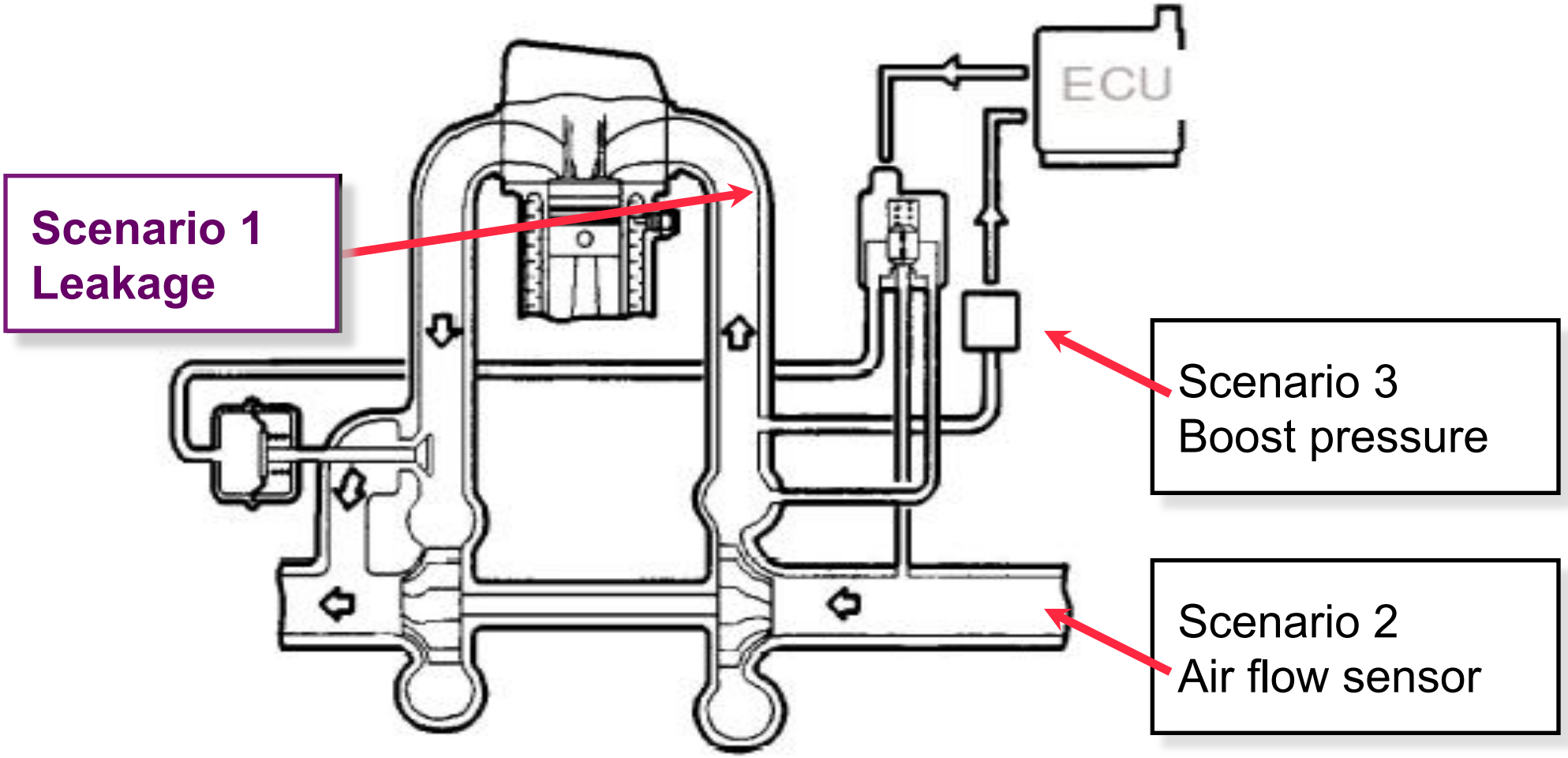
Demonstrator Vehicle Set-Up



Demonstrator Car (Volvo) with RAZ'R

Demonstrator Car (Volvo) Switchboard for Fault Injection

Demonstrator Turbo Control Subsystem



VMBD Demonstrator: Leakage in Air Intake