

Requirements Engineering for embedded systems



BOSCH

ETAS
Engineering Tools

Telelogic **TUM**



Model Based Requirements Engineering for Embedded Software

Christian Schröder¹, Martin Rapp², Peter Braun² and Michael von der Beeck³

¹Telelogic Deutschland GmbH, Bielefeld

²Technische Universität, München

³BMW Group, München

Contents

- Survey of Requirements Classifications
- AUTOMOTIVE Requirements Engineering Process
- Model Based Requirements Classification
- Tool Support

Survey of Requirements Classifications

„Qualitative improvement of requirements documents“

- Checklist for requirements elicitation
- Structuring rules for requirements
- Smooth transition from informal requirements to models

Classification Approaches

- V-Modell
- VDMA
- CMM
- MIL standards
- DoD standards

Functional Requirements

„ ... are related to functional aspects of the system“

- Inputs (data, events, stimuli, ...)
- Reactive Functions
- Output (data, events, stimuli, faults, ...)

Non-functional Requirements I

Quality Attributes

- Real time constraints
- Allocation of resources
- Maintenance
- Reliability

Product Requirements

- Realisation in software/hardware
- Distribution of components
- Required interfaces

Non-functional Requirements II

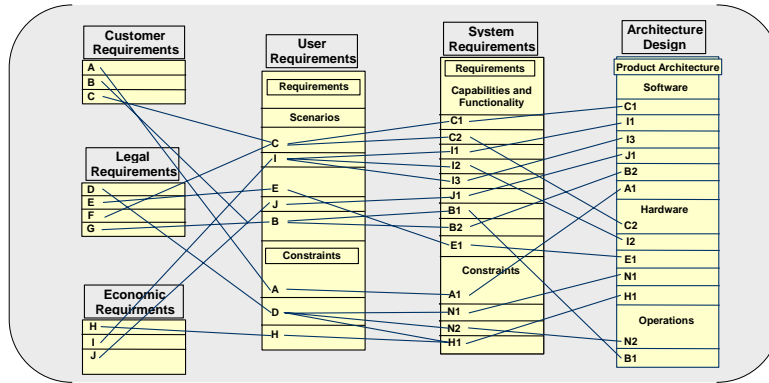
Process Requirements

- Kind of development
- Process model
- Management activities
- Methods
- Tools

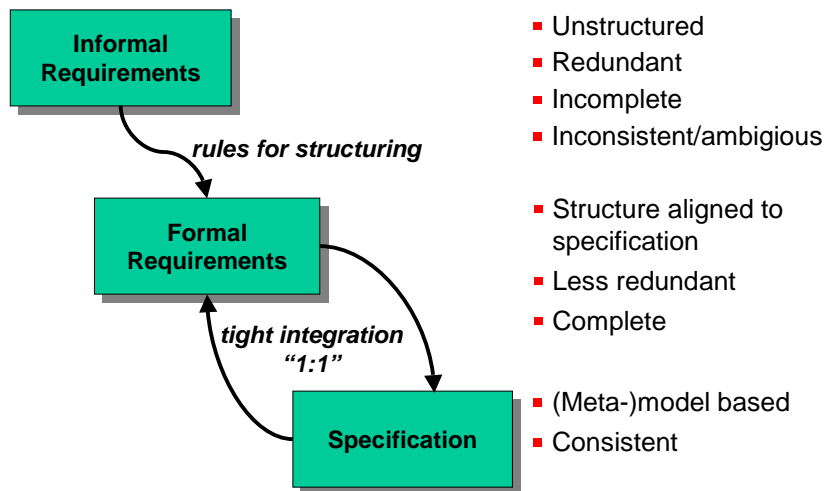
General Conditions

- Test preparation
- Acceptance terms
- Qualification of operation
- Service
- Training

Traceability of Requirements



AUTOMOTIVE Requirements Engineering Process



AUTOMOTIVE Modeling Concepts

- Classified model elements
- Variants and instances of model elements
- Hierarchical model structure
- Dependencies between model elements
- References to model elements

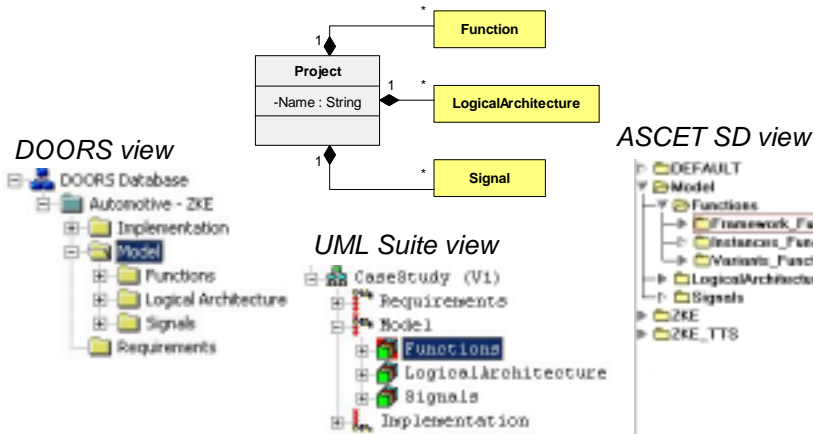


Classes of Information

- Signals
- Functions
- Logical architecture
- Control Units
- Real time operating systems
- Central processing units
- Communication infrastructure

Metamodel Oriented Derivation of Structuring Rules

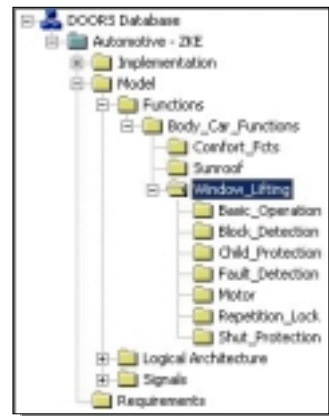
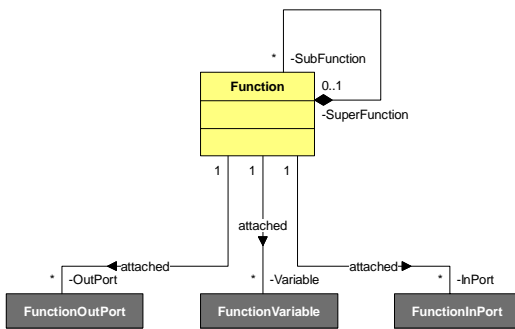
- „... provides unifying concepts for model integration“



Example: Hierarchical Structuring of Functions

Metamodel structure

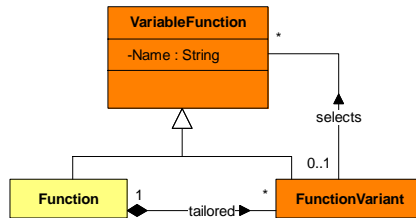
Pre-configured document structure



- Mapping metamodel relationship „composition“ on folder hierarchy

Example: Tailoring of Functions to Variants

Metamodel structure



Pre-configured document structure

| ID | Name | Type |
|----|---|--|
| 1 | 1.5 Variants | |
| 2 | 1.5.1 FrontDoor | Variant |
| 22 | 1.5.1.1 Differences to original function | |
| 23 | No child_protection | |
| 50 | 1.5.1.2 Selected subfunctions and function variants | |
| | Basic_Operation | Autobahn - 3D Model/Functions/body_car/Functio |
| | Block_Detection | Element |
| | Repetition_Lock | Element |
| | Shut_Protection | Element |
| | Motor | Element |
| | Fault_Detection | Element |

- Mapping metamodel relationship „tailored“ on folder hierarchy
- Mapping metamodel relationship „select“ on element references (using the DOORS link mechanism)

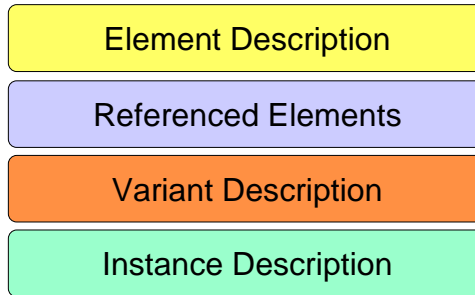
Pairing of Functional and Non-functional Requirements

- „... is forced throughout the whole model!“

| None | Type |
|----------------------------|--------|
| Basic_Operation | Folder |
| Block_Detection | Folder |
| Child_Protection | Folder |
| Fault_Detection | Folder |
| Motor | Folder |
| Repetition_Lock | Folder |
| Shut_Protection | Folder |
| Functional Requirements | Formal |
| Nonfunctional Requirements | Formal |

Functional Requirements

- „... are defined using pre-configured function description cards“



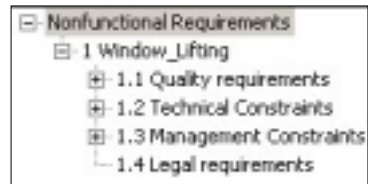
Example: Case Study „Window Regulator“

- Function description card for function „Window_Lifting“

| ID | Type |
|-----|---------------------------------|
| 1 | 1 Window_Lifting |
| | Element |
| 1.1 | 1.1 Short description |
| | Functional Requirements |
| | Window_Lifting |
| | 1.1 Short description |
| | 1.2 Application |
| | 1.3 Subfunctions |
| | 1.4 Interaction of Subfunctions |
| | 1.5 Variants |
| | 1.6 Instances |
| 1.2 | 1.2 Application |

Non-functional Requirements

- „... enrich the model with quality, technical, management process, and legal requirements“



Summary

The Benefit of Model Based Requirements Classifications:

- Complete and consistent requirement specifications
- „1:1“ tight integration of requirements with models
- Reduction of linking expenses
- Ease of change management