Integrated Modeling for Engineering Complex Heterogeneous Systems

SWISSED 2016

Markus Schacher & Rolf Gubser, KnowBodies
Overview

• Engineering Complex Systems

• Modeling and Modeling Languages

• Example Case Study

• Summary
ENGINEERING COMPLEX SYSTEMS
"Engineering is the discipline, skill, and profession of acquiring and applying scientific, economic, social, and practical knowledge, in order to design and build structures, machines, devices, systems, materials and processes."

Wikipedia, 2012

"Hardware eventually fails. Software eventually works."

Michael Hartung
Engineering Complex Systems

Business Engineering
Product (Line) Engineering
Terminology Engineering
Requirements Engineering
Mechanical Engineering
Software Engineering
Electrical Engineering
Test Engineering
Safety Engineering
MODELING AND MODELING LANGUAGES
Models

"All models are wrong, but some are useful."

George E. P. Box,
"one of the great statistical minds of the 20th century"

(Our) Definition: A model is a thing that may be used, for a specific purpose, as a simplified description of an original.
There are **exactly two** (good*) **Reasons**:

1. **To communicate**
   a) **To exchange ideas**
   Example: a discussion on solution alternatives
   b) **To prescribe a desire**
   Example: a product specification

2. **To understand**
   a) **To analyze an original**
   Example: reverse engineering a legacy system
   b) **To predict some properties of an original**
   Example: weather forecast

* There are also some less good reasons such as "my boss said it", "one does it", "it is cool", etc.
The Unified Modeling Language™ (UML) is OMG's most-used specification, and the way the world models not only application structure, behavior, and architecture, but also business process and data structure.
By means of so called "Profiles", UML supports the definition of Domain Specific Languages (DSL) that may be utilized using commonly available UML modeling tools.
Modeling Languages

The Object Management Group (OMG) has defined a number of modeling languages that may be implemented using UML Profiling:

- **Business Motivation Model (BMM)**
- **Semantics of Business Vocabulary and Business Rules (SBVR)**
- **Business Process Metamodel and Notation (BPMN)**
- **Systems Modeling Language (SysML)**
- **UML Testing Profile (UTP)**
- ...

**Non-OMG UML Profiles:**

- **Risk Analysis (RIAL)**
- **Executable Specification in UML (xUML)**
- ...

EXAMPLE CASE STUDY
Semantics of Business Vocabulary and Business Rules (SBVR)

A door at a level that gives access to a shaft.

Define a business terminology that supports multiple communities
Define a business strategy for a product using the shared terminology
Design the technical anatomy of the product in terms of logical and physical components
Executable Specifications in xUML

Design the functional logic of the product
Risk Analysis

Analyze the safety and reliability of the product's components
UML Testing Profile (UTP)

Test the functional logic of the product.
**Total Modeling**

*One model as central repository of all project information*

- Conceptual Documents
  - Techn. Architecture
  - Test Specifications
  - Funct. Specifications
  - Goals & Requirements
  - Operational Processes
  - Project Context
  - Projekt Planning
  - Project Vocabulary
  - Safety Analyses

**All documents may be automatically generated – no manual writing!**
SUMMARY
Summary

• Models are made to communicate, analyze or predict properties of an original (a system)

• Developing complex systems requires tight collaboration between multiple engineering disciplines

• UML may be used as a "host language" to integrate multiple domain specific languages into one common model shared by multiple engineering disciplines

The whole is more than the sum of its parts!
Thank you for your attention!