MBSE – Master Complex Development More Easily

25.03.2021
YOUR HOSTS

Viviane Zimmermann

Head of Business Area Industry | Stuttgart

Responsible for customer development in the industry sector

With UNITY since 2007

> 12 years of experience in innovation, organizational development and creating customer experience

... keep the brain working.

Dr.-Ing. Tobias Wigger

Manager | Büren

Systems Engineering Expert at UNITY

With UNITY since 2014

> 8 years of systems engineering experience in various industries

... Success has 2 Letters - DO

Dr.-Ing. Stefan Schlichting

Manager | Hamburg

Systems Engineering & Interoperability Expert at UNITY with a background in MedTech and IT

With UNITY since 2020

> 10 years of experience with innovation, technology & product development & systems engineering

... Thinking about data on the inside & the outside
AGENDA

- SHORT INTRODUCTION
- MODEL BASED SYSTEMS ENGINEERING
  I. CONTEXT OF MBSE
  II. MBSE IN REALITY
  III. CONCLUSION
UNITY in Systems Engineering

Scientific Network
UNITY as an important key player in the SE network

Customers
Successful projects across all industries

Publications
Numerous references and publications

More than 100 customers, among others in the automotive, aviation and mechanical engineering industry.
QUESTIONS & INTERACTION
Please use the chat function.

TWO SURVEY BLOCKS
Please use the embedded survey tool for this purpose. The survey will be displayed automatically.

Please participate in a feedback survey after our online seminar.

The recording and documents of the webinar will be made available to you.
How familiar are you with MBSE?

1. Newbie
   (I have no experience with MBSE and system modeling)
   - 28.6%

2. Beginner
   (I know the terms & have an idea how models are used)
   - 51.4%

3. Professional
   (I have initial experience using MBSE)
   - 14.3%

4. Expert
   (I am experienced in MBSE and the use of system activities)
   - 5.7%
The Context of MBSE
The Need for Systems Engineering
Complexity of development is increasing exponentially

- Autonomous Care
- Guided Care
- Assisted Care
- Clinical Information Visualization
- Information Availability in IT-Systems
- Stand-alone Medical Devices

Stand-alone Devices

Data Analytics

Automation

Complexity

Development processes improve linearly

Gap

MedTech

Time

Today

25.03.2021 Webinar MBSE – Master Complex Development More Easily

© UNITY Confidential
Defined Costs vs. Incurring Costs during the Life Cycle

Concept
Development
Production
Utilization
Support
Retirement

Lifecycle costs over time

The 1st phase is of utmost importance!

Defined costs

Cost for deficiencies removal

Factor 3…6
Factor 20…100
Factor 500…1000

Incurring costs

Defined costs vs. Incurring Costs during the Life Cycle

Utilization
Support
Retirement

The 1st phase is of utmost importance!
Systems Engineering in a nutshell

Drivers of change
- System of Systems
- Connectivity
- VUCA and Agility
- Business models
- Laws and regulations

System structure
- System of Systems
- System levels
- System elements

Processes, methods and IT
- System lifecycle
  - Concept
  - Development
  - Production
  - Operation
  - Maintenance
  - Disposal
- Project-and Process-Mgt.
- Configuration, Change- and Release-Mgt.
- Integration, Verification & Validation
- Architecture-Mgt.
- Synchronisation of domain disciplines
- Requirements-Mgt.
- Engineering IT
- Development organisation groups

Organisation
- Roles and Responsibilities
- Ensemble of Project and line org.

Competencies
- SysEng Qualification
- Methods and Tools Qualification

Goals
- Early virtual verification / validation
- Right first time
- Optimal system design
- Traceability & Compliance
- Customer value and User Experience

Focus: Systems Engineering

Drivers of change

System structure

Processes, methods and IT

Organisation

Competencies

Goals
Definition

“Model Based Systems Engineering”

The formalized application of modeling to support ..

...system requirements, architecture, design, analysis, verification and validation activities

...beginning in the conceptual design phase and continuing throughout development and later life cycle phases

MBSE in the context of Systems Engineering

The main function of SE is to facilitate communication!
But how?

**MBSE is a …**
- … planning systematic for the specification of complex systems
- … help to structure, maintenance and traceability of complex related information
- … information hub

**MBSE is not…**
- … equal to Systems Engineering
- … an automatic guarantee for project success
- … a toy

**Effectiveness**
METHOD
„Doing the right thing!“

**Language**

**IT Tools**

**Efficiency**
TOOL
„Doing it right!“
What is a model?

Typical Questions about a System-of-Interest

How is the system decomposed into subsystems?

How does the architecture of the system satisfy the allocated system and subsystem requirements including those relating to risk control?

Which interfaces exist between components?

How is the dependency of subsystems structured?

How are external interfaces of the system linked to sub-systems?

A model of „A“ is used in place of „A“ to answer questions about „A“. 

Marvin Lee Minsky
1927-2016, American scientist
Document-based vs. Model-based approach

Traditional systems engineering

Model-based systems engineering

Madni et.al. 2019
MBSE – Investments and gains

Factors related to MBSE investment

- Cost of Process Definition
- Infrastructure Cost
- Training Cost
- Model Development
- Model Verification
- Model Curation
- Configuration Management

Factors related to MBSE gains

- Early Defect Detection
- Reuse
- Risk Reduction
- Improved Communication
- Usage in Supply Chain
- Product line Definition
- Standard Conformance & Traceability

Madni et.al. 2019
What is your main driver for applying MBSE?

1. None: 2.6%
2. Improved communication: 25.6%
3. Improved quality: 33.3%
4. Improved productivity: 33.3%
5. Other: 5.1%

39 Participants / 25.03.2021
Those who know the options of the business can react to changes in a targeted manner.
MBSE supports RFLP approach

Legend:
- Focus area within the V-Model

MBSE facilitates the definition, relation and documentation of system specification

MBSE model elements as basis for development and other artifacts
UNITY MBSE Framework

Requirements  Context  V&V  Functionality UseCases + Functional architecture

Logical architecture

Physical architecture

Additionally Parametrics can be used for Trade Studies and Measurement activities, Simulation integration not depicted
Aspects of Practical MBSE Application: Publishing & Reviewing

The MBSE approach interfaces well even with traditional information structures. It's a question of customization.

Different views for different stakeholders in the model environment

- Specification Tree
- Target Costing
- Direct model element export
- Interface Specifications

Different views outside of the model environment

- Model Repositories
  - Specifications
  - System Analysis
  - Functional Architecture
  - Logical / Physical Architecture
Model Based Systems Engineering @ VividBreath

Preparation
- Stakeholder Needs
- Intended Use / Purpose
- Base Architecture & System Context

Functional Architecture
- Function structure & behavior
- Function relations, flows & interfaces
- Functions related to Risk Control

Logical Architecture
- Logical structure & behavior
- Log. element relations, flows & interfaces
- Elements related to Risk Control

Physical Architecture
- Physic structure & behavior
- Phy. Element relations, flows & interfaces
- Domain architectures
- Identify elements related to Risk Control

Create documentation for discussion with authorities in selected countries to prepare emergency use authorization
VividBreath Oxygen Concentrator - Functional Structure

 improving collaboration
 facilitating communication
 holistic understanding
VividBreath Oxygen Concentrator - Functional Network : Supply Gas
VividBreath Oxygen Concentrator - Logical System Structure
VividBreath Oxygen Concentrator - Functions to Architecture Allocation

<table>
<thead>
<tr>
<th>Function</th>
<th>L0</th>
<th>L1</th>
<th>L2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Oxygen Enriched Air</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Generate O2 Enriched Air</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Maintain System (context Services)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Protect Environment</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Protect from Environment</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Supply Gas</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Adjusting flow rate (context User)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Capture ambient air</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Concentrate O2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Connecting O2 supply (context O2)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Deliver O2 Enriched Air</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Filter Gas (context Micro Particle Filter)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Indicate primary function performs</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Protect against electrical hazards</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Protect against excessive accoustic</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Protect against excessive heat</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Protect against moving parts (context)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Conclusion
Don’t conquer the world in one go. Take one measured step at a time, all oriented on actual benefit.
SE-Frontloading requires a change of the mindset.

Embedding MBSE in PLM is the key to sustainable implementation, but not a prerequisite at the beginning.

MBSE is not synonymous with All-In.

The effort must remain reasonable in comparison to the complexity.

The challenge at MBSE is to focus on the essential (producing effectiveness).

Through appropriate model design, many disciplines can participate in the information flow earlier.

Communication is everything in complex development projects.

Tailoring at project level is everything. The effort must remain reasonable in comparison to the complexity.
LANDED!
AND NOW?

LET’S DISCUSS MBSE!
MODEL BASED SYSTEMS ENGINEERING
The Truth is in the Models.

In the future, system models will be the backbone of organizations and will play a major role in answering economical and technical questions. Integrated models reduce inconsistencies and enable automation to support work, virtual verification. The key to building system models lies in Model Based Systems Engineering (MBSE), which provides the framework for system development with a common language and integration processes and methods. The consistent application of system models is ensured by embedding MBSE to holistically transform processes, methods, tools and the organization.

Model Based Systems Engineering
YOUR CONTACT
FOR YOUR PERSONAL DISCUSSION

Viviane Zimmermann
Head of Business Area | Stuttgart
Viviane.zimmermann@unity.de

Dr.-Ing. Tobias Wigger
Manager | Büren
tobias.wigger@unity.de

Dr.-Ing. Stefan Schlichting
Manager | Hamburg
stefan.schlichting@unity.de

BERLIN
BRAUNSCHWEIG
FRANKFURT
HAMBURG
CAIRO
COLOGNE
MUNICH
NUREMBERG
PADERBORN
BEIJING
SÃO PAULO
SHANGHAI
STUTTGART
VIENNA
ZURICH