### Abstract

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## **Multi-Tool MBSE**

Successful digital collaboration demands thinking beyond a single MBSE tool and SysML only

Due to an ever-increasing complexity of modern systems, driven by increasing interconnectivity, x-domain and cross-organizational development in global teams, the ancient document-centric systems engineering approach leads to increased development effort and time. Reducing this effort and time demands a shift into a x-functional digital collaboration approach, which shall enable the lifecycle engineering beyond a single engineering discipline.

From a method perspective a multi-domain information model enables a seamless connection of the already well-established domain specific languages. Further, beyond SysML, a domain specific language for systems engineering is required on top to enable the collaboration between the different domains. The major aspects of this domain specific language for systems engineering are the concept of self-similarity and a clear distinction between the required and guaranteed aspects to be modeled.

From a cultural and technology perspective the required change demands to overcome the historically grown non-collaborative team culture within large organizations as well as the still limited connection capability of the different domain specific tools.

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Successful digital collaboration demands thinking beyond a single MBSE tool and SysML only

SWISSED24, Zürich

Dr. Ralf Hocke | Dr. Stefan Setzer September 9<sup>th</sup>, 2024



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- Motivation
- Multi-domain information model
- x-Domain model collaboration
- Transition challenges



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# Today's diverse challenges lead to significantly increased complexity, demanding to change how we work





**Increasing systems interconnectivity** of previously isolated Healthineers products



#### Sustainability and circular economy



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#### System complexity steadily increases on all hands

#### Market

#### • Regulations (e.g., local standard)

• Business models (e.g., reimbursement models)

#### Technology

- Complexity (e.g., complex (super-) system integration)
- Fast Changes (e.g., workflow and technology innovations)

#### Environment

- Globalization
  - (e.gl, vulnerable to supply shortages)
- Sustainability (e.g., circular economy targets)

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## Improve collaboration within and between teams Business benefits from the development perspective



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## Digital Lifecycle Engineering From distributed knowledge in documents ...





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Service

## Digital Lifecycle Engineering ... via a cultural change ...



The future – Divide & Collaborate



Matching/alignment



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## **Digital Lifecycle Engineering** ... to consistent lifecycle knowledge in a single point of truth



#### Consistent knowledge in a single point of truth

(joined and consistent model connecting domain specific information)



Converging Matching/alignment

The future –

Partner

I require

Instantaneous feedback on consistent information at any time

**Enables seamless and agile collaboration** 

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Service



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## DiSEF – The idea of «MBSE in a slide» from Jon Holt<sup>1</sup> applied to a multi-domain/-tool landscape





Healthineers specification approach: "Digital Systems Engineering Framework – DiSEF"

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# The MBSE Domain Specific Language (DSL) is a major part of the Healthineers DiSEF





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Structure

Qualities & Attributes

\_ \_ \_

- QA

# Subsequent decomposition results in a subsequent integration of Systems into Systems $\rightarrow$ Self-similarity

Like a "Penguin" matryoshka ...





- From its perspective every "Penguin" on each level is a "System", independent of its size
- Thus a "**Penguin**" can represent the documentation of any element/asset<sup>1</sup> on each layer of the system assembly structure.

→ The "system penguin" is a composition of smaller "penguins" being integrated following the system assembly structure

Self-similarity of the element documentation

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Healthinee

1 Element or Asset is the generic term for {system, subsystem, component, module, ...}

### A self-similar model is the prerequisite for model collaboration



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### Model-based iterative incremental development Virtual x-domain collaboration





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## Applying the "magical number 7<sup>"1</sup> to system decomposition reveals Healthineers why collaboration and decomposition is essential for success



<sup>1</sup> Millersche Zahl – Wikipedia | The Magical Number Seven, Plus or Minus Two - Wikipedia

## **Iterative incremental development Virtual x-domain collaboration in larger setups**





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# The transition into model-based systems engineering is also a cultural challenge, not only a technical one

The future The past "Be right at the right time" Divide & collaborate Divide & conquer Uncertainty decreases "First time right" Cone of uncertainty **Back to normal** -onstant chang Model stabilizes To be Model-based As is Document-based Normal ⊾ † → Time •  $t_{n+m}$ t<sub>n</sub> Low maturity (unstable) High maturity (stable) Ready for formal V&V "Contract" require require I guarantee "Continuous OK Collaboration" Silo The challenge Customer approach Partner Partner Establish a positive failure culture **Supplier** 

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## Value-driven transition path into a x-functional multi-tool Systems Engineering Framework



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