WORKSHOP

Practical insights into web-based, collaborative engineering of complex hardware systems

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Goals

• Learn how modern web technologies can help you streamline your engineering processes

• Gain practical insights into web-based tools

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Outline

• MBSE and current approaches (~30 min)
• Web based tools and platforms (~20 min)
• Modeling in Valispace (~10 min)
• Hands-on exercise with Valispace (~40 min)
• Conclusions (~10 min)
Intro

• What is your name?

• What industry do you work in?
SATELLITE ENGINEERING

WHAT WE THOUGHT WE WOULD DO

WHAT WE REALLY DO
MBSE and current approaches
Brainstorming exercise

What comes to your mind when you hear “Model Based Systems Engineering”?
Currently used MBSE tools

- NoMagic MagicDraw
- Artisan Studio
- IBM Rhapsody
- Sparx Systems Enterprise Architect
- InterCAX ParaMagic
- Microsoft Visio
Drawbacks of current MBSE systems

• Still mostly an academic field
• Application today only useful in early phase studies
• After early studies the models are abandoned
• Requires time and effort spent on training
• Models don’t prevent inconsistencies
• MBSE tools are not flexible enough
Drawbacks of current MBSE systems

“A fully operational MBSE process with a corresponding tool set has not yet been realized in space projects today.”
(Eisenmann et. al. 2009)

There is a “lack of perceived value of MBSE” (Motamedian 2013)

“MBSE needs significant evolution for interoperability significantly for a ‘plug and play’ of different tools.”
(Eisenmann et. al. 2015)
MBSE in industry?
Short survey: tools used in industry

**Simulation and calculation tools**
- Excel
- MATLAB
- Simulink
- Other
- Google Sheets
- SolidWorks
- Custom
- None
- Fluent
- GNU Octave
- Mathematica
- Python

**Data management tools**
- Excel
- Word
- PowerPoint
- Google Docs
- Rational DOORS
- Other
- Confluence
- None

[Bar charts showing the percentage usage of various tools in simulation and calculation, and data management.]

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Short survey: tools used in industry

**Requirement tools**
- None
- Rational DOORS
- JIRA Software
- Other
- Agile Manager
- Blueprint
- Jama Software
- TraceCloud
- Visure Requirements

**Modeling and design tools**
- None
- Other
- Dassault CATIA
- Autodesk AutoCAD
- Solidworks
- Ansys
- Eagle
- PTC Creo
- Autodesk Inventor
- FreePCB
- Siemens Solid Edge
Short survey: statements

- In my current project I often see inconsistencies in the documentation.
- I often copy-paste data between the different tools I use (e.g. emails, Excel, Word, MATLAB).
- I spend much of my time writing engineering reports and documentation.
- In our team there are often misunderstandings about what the current technical baseline is.
- I always receive a notification about a change in the project data.
- In my current project it is easy to get an overview of the product development.
- In my current project it is easy to find data that I need for calculations or presentations.
- In my current project the project data is well organised.
Short survey: statements

Statement rating - average

Strongly agree: 10

Strongly disagree: 0

S1 S2 S3 S4 S5 S6 S7 S8

Negative Positive
Short survey: desired features

**Desired features of engineering tool**

- User friendly
- Automatic change notifications
- Connection to other tools
- Offline/remote working
- Version control
- Connected data
- Collaboration in large teams
- Data visualisation
- Flexibility
- Requirements tracking
- Calculation capability
- Simulation capability

%
Web-based tools and platforms
Why web-based?

• Concurrency
  • **Real-time**, concurrent access to data for all users
  • Data consistency by design: “**Single source of truth**” (contrary to file-based systems)
  • **User-friendly** with short learning curve
  • Tools can interact without user intervention

• Data driven
  • Information is stored, processed and made available as **data** (not text)
  • Allows for access, search, filter, sort, **calculations**, re-use etc.
  • Proprietary, non-standardized models are **better than no models at all** („hidden MBSE“)
  • **Standardized APIs** (e.g. REST)
Tool stack

„In computing, a solution stack or software stack is a set of software subsystems or components needed to create a complete platform such that no additional software is needed to support applications.” *

*https://en.wikipedia.org/wiki/Solution_stack
Interoperability

- Most web-based tools implement „REST“-API
  - Allows for **automatic** read-, write-, list-, update- and delete-functionality
  - Many vendors build tool integrations themselves
    (e.g. Onshape → Simscape)
  - Some vendors allow users / other vendors to build integrations
    (e.g. Slack)
  - Dedicated services exist to combine web-tools (e.g. IFTTT)
Modeling in Valispace
Modeling with Valispace

Valispace is a COTS software developed for use throughout the development cycle of a hardware project.
Structure and parametric modeling
Modes/states modeling

\[
\begin{bmatrix}
\text{LAUNCH} \\
\text{SCIENCE} \\
\text{SAFE}
\end{bmatrix} =
\begin{bmatrix}
0 & 1 & 0 \\
1 & 0 & 0 \\
0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
\text{ON} \\
\text{OFF} \\
\text{STANDBY}
\end{bmatrix}
\]

Satellite power consumption

OBC power consumption
Connected copies

connected objects

Disconnected objects

Object1

Object2

Object3

Object4

RW1

Connected to RW2, RW4, RW3

Valis defined in this component

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<th>Value</th>
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</tr>
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Hands-on exercise with Valispace
Conclusions