Aircraft System Model in SysML Multi-disciplinary Simulation and Analysis for Early Virtual Integration

Connect Systems Models in SysML 3DEXPERIENCE Platform and other Models Using Process Composer

Saulius Pavalkis, PhD
CATIA NO MAGIC - CYBER SYSTEMS Industry Business Senior Consultant and MBSE Transformation Leader
Agenda

- Introduction to MBSE with SysML and Catia Magic / Cameo Systems Modeler
- System architecture simulation and analysis in SysML
- MBSE ecosystem
- Multidisciplinary simulation orchestration and analysis - Process Composer
- Connect Cameo Models to 3DEXPERIENCE Platform models in Process Composer
- Next steps
- Conclusions
Overview

Decreasing time-to-market phases and the increasing complexity of future systems make it difficult for engineers to test the proper performance of the systems, implement changes, and optimize system architecture. With help of system model in SysML simulation and integration with multidisciplinary engineering tools we can reach high level maturity of MBSE / digital engineering adoption. In this webinar we will present state of the art solution:

- Cameo Systems Modeler aircraft SysML project simulation.
- We will connect SysML model with Dassault Systems 3DEXPERIENCE Platform Process Composer for multidisciplinary simulation orchestration leveraging multiple models and simulations.
- We will simulate system model in context of aircraft geometry and mission parameters.
- We will perform requirement verification.
**Today:** Standalone models related through documents

**Future:** Shared system model with multiple views, and connected to discipline models
Existing Modeling Practice
Analysis Simulation and Verification
Standards Compliance
Regulatory Compliance

Management of Complexity
Requirements Traceability and Verification
Modularity and Reuse
Strong Partner with Experience

Model Based Systems Engineering provides paradigm shift

- Defects caught earlier in the process
- Less expensive to address at these stages
- Overall quality improves

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System engineering process (V process)

Credits: Pawel Chadzynski & Michael Pfenning - MBSE and the Business of Engineering
The system model flows down, and is interconnected with the subsystem requirements and emerging designs. These design are instantiated in different models based on their governing physics (stress/strain, fluids, electro-magnetic, etc.)
MBSE Maturity Model

Modeling a system without following a framework, without a formal language and with a tool supporting the standards

Descriptive Modeling with a framework, with a formal language and with a tool supporting the standards

Modeling facilitates execution, Verification & Validation.

Modeling is integrated with other downstream design disciplines

Model remains the Single Source of Systems Truth from the inception till the End of life of the System

- Communicability
- Greater insight into design and intent
- Early Convergence
- Confidence
- Efficiency
- Integration with design disciplines
- Source of Truth
- Model Fidelity

Source: Chris Schreiber
Systems Engineering Senior Manager at LMCO, JPL MBSE Symposium 2019
Use Cases

- System level multidisciplinary trade studies
- Parametric optimization
- Requirements V&V

Source: Chris Schreiber
Systems Engineering Senior Manager at LMCO, JPL MBSE Symposium 2019
Leading Standard Based MBSE Solution by CATIA | No Magic

System Modeling

Example of a Hybrid SUV

System Simulation

System Analysis
Cameo Simulation Toolkit

Model execution framework:
- Model debugging and animation environment
- Pluggable engines, languages and evaluators
- User Interface prototyping
- Co-simulation orchestration

The standard based model execution of:
- Activities (OMG fUML standard)
- Composite structures (OMG PSCS)
- Statemachines (W3C SCXML and OMG PSSM standards)
- Actions/scripts (OMG ALF, JSR223 scripting)
- Parametrics (OMG SysML standard)
- Sequence diagrams (OMG UML Testing Profile)

Analysis Capabilities:
- Automated Requirements Verification
- Trade studies / trade-off analysis
- Mass/cost/power rollups
- Timing and duration analysis
- Monte Carlo analysis
- Model-based testing
- Co-simulation environment
3DEXPERIENCE V+R Process Apps Overview
Process Composer App

Create processes that integrate your applications, disciplines and data

- Capture and deploy expert methods
- Graphical Process Builder
  Drag-and-drop process authoring
- Exchange data and execute
  - DS applications
  - External Applications
- All processes types
  Man-in-the-loop and/or automated
Activities

Material Properties → 4 Adapters inside the Activity → Run Surrogate Model → FEA Simulation
Process Composer Adapters

- Upload/Download Content
- OS Command
- Delete Content
- Text Parser
- Calculator
- Java Script
- 3DX Script
- Create Report
- Approximations
- Data Matching
- Co-Simulation
- Update Attributes
- Excel
- MATLAB
- Abaqus
- Isight
- DOE
- Loop
- Optimization
- Monte Carlo
- Exchange 3DX parameters
- 3DX Utility
- 3DX App
- 3DX Simulation

...Or create your own!
Use Native or External Tools
Automated, Exploratory, Hierarchical Processes

Automatically execute data movement, data exchange and application execution. Iterate execution of a sub-process using specific logic.
Design Exploration Techniques

Most DOE, Opt, MCS and Approx techniques from Isight are included in Process Composer
What is a Simulation Experience?

What’s in the black box?

- 3rd party or custom developed tools (Excel, MATLAB, Nastran, etc.)
- 3DEXPERIENCE data (Engineering Items, Requirements, Logical or 3D Fluid or 3D Structural Simulations, etc.)
- Combination/multiple of the above in sequence and/or with branching
- Exploration, loops, optimization, robustness
Create simulations in SIMULIA Process Composer and share as templates on the 3Dx platform

Drag’n’drop to CAMEO diagrams and expose inputs/outputs

Connect SysML parameters and launch the simulation in CAMEO Simulation Toolkit

Executes in SIMULIA and gets results back to CAMEO to verify
3DX maintains Design, Project, Reqs Traceability

**Milestones**
- Concept
- Preliminary
- Detailed

**Via Simulation Experiences**
- Lifecycle Controlled
- Secure Access
- Single Source
- Execute Anywhere

**Increasing Fidelity**

- 1st Principle Equations
  \[ F = \dot{m}e V_e - \dot{m}_0 V_0 + (\rho_e - \rho_0) A_e \]
- 1D Thrust Analysis
- Aeroacoustic 3D Simulation
- 3D Fluids Simulation
- Control Surface Analysis
- Lookup Tables

**1st Principle Equations**

**3DX**
Porting simulation code to the server/platform side

CST MD Plugin
- Engines
- Animation
- External integrations

MD API
- Model execution core
- UML/SysML API

MagicDraw
- 19.0

Alpha
- MD Plugin
  - Animation
  - Debug
  - UI, Plots
  - Integrations
- Web App
  - REST API
  - Commits
  - CC
  - HTML UI

Standalone
- No UI
- Command line
- Mockups

Platform integration
- Standalone
- No UI
- Command line
- Mockups

Platform
- 2021x
- MagicDraw
- TWC
- MDZIP
- 3DS
SIMULIA Process Composer integration roadmap

▶ v2021x
▶ Login to the platform
▶ Simulation template drag’n’drop and invocation in Activity or Parametric diagram

▶ Next
▶ Tool adapter interface for CAMEO in PC
▶ Design Exploration and Results Analytics
▶ Commercial solution
The Pinnacles of Integration

**MBSE Maturity**

Reach Highs MBSE with Simulation Maturity Level:
- Optimize your system with system architecture, design and analytical models in the loop.
- Integrated workflow

**Integrated Analysis and Simulation**

Perform Integrated Analysis:
- Integrate system model for quick V&V, change, trade study optimization, analysis

**Unified Simulation Interface**

Unified Interface Between System Model and Simulation:
- Brake engineering silos
- Use engineering and system engineering simulation models together easily

Realize Model-Based Requirements Engineering to Its Fullness
Lets keep in touch!

Saulius Pavalkis
Saulius.pavalkis@3ds.com