



3DEXPERIENCE®

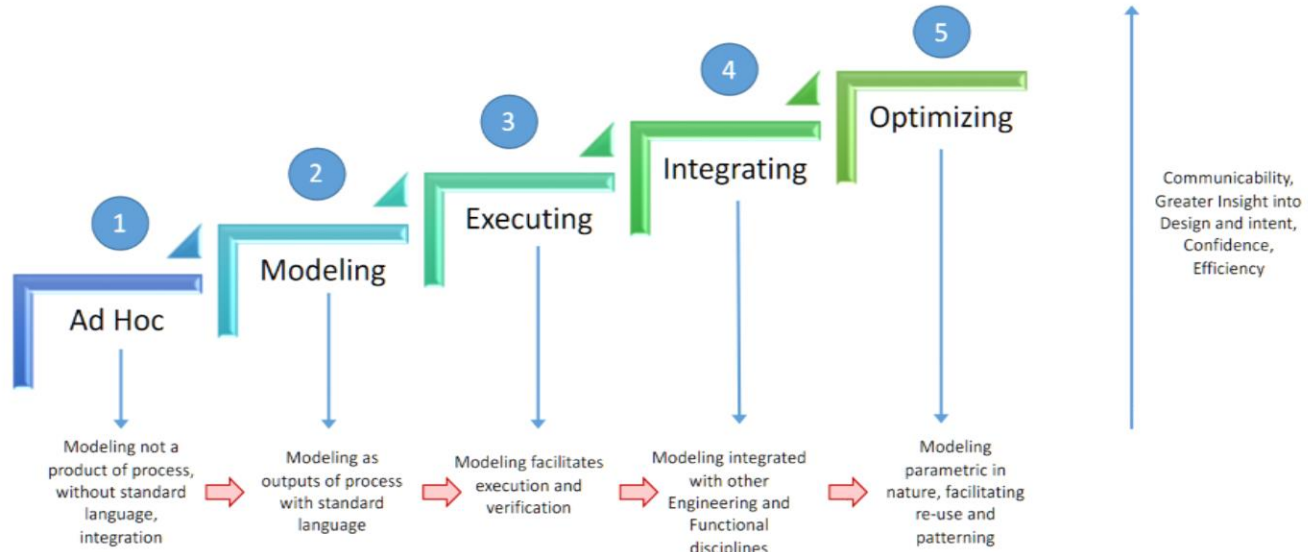
Executable Systems Modeling with SysML

Interface Between Descriptive and Analytical Models

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INCOSE IW Jan 2019

No Magic

MBSE Maturity Model



Integrating MBSE into a Model-Based Engineering Environment

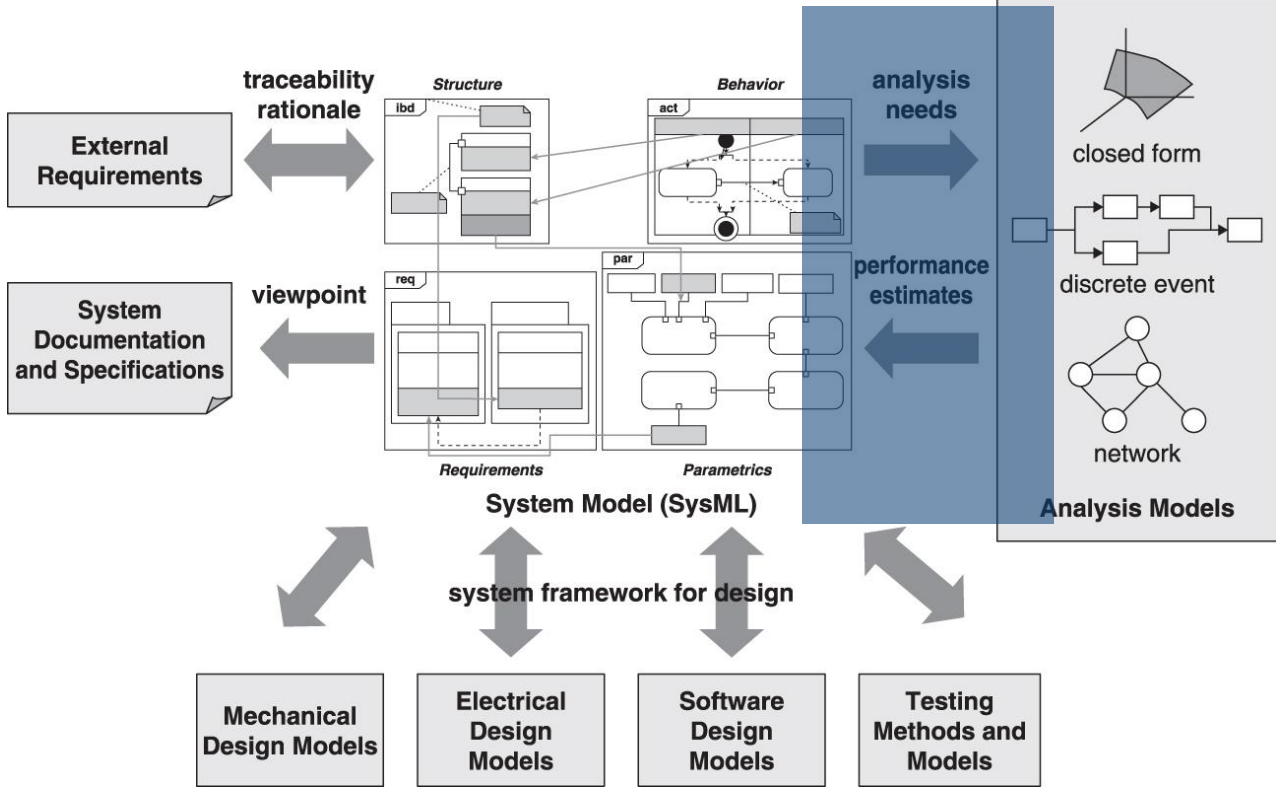
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NASA – JPL MBSE Symposium 2019

Chris Schreiber

Systems Engineering Modernization Sr. Manager – LM Space

System Model as an Integration Framework

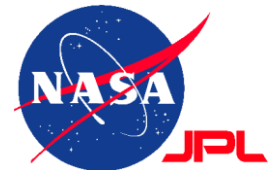


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Interface Between Descriptive and Analytical Models



No Magic



Cameo Simulation Toolkit

Execute model to simulate system

The standard based model execution of:

- Activities (OMG fUML standard)
- Composite structures (OMG PSCS)
- State Machines (W3C SCXML standard)
- Actions/scripts (JSR223 standard)
- Parametrics (OMG SysML standard)
- Sequence diagrams (OMG UML Testing Profile)

Model execution framework and infrastructure:

- Model debugging and animation environment
- Pluggable engines, languages and evaluators
- User Interface prototyping support
- Analysis: Monte Carlo, Duration, Power Rollup, trade studies..

“This is an important development since it requires minimal configuration, can be used earlier in the lifecycle and can evolve as the design matures.” - NASA Perspective on Recent Trends in Executable Models

Demo

▶ System Model

- ▷ Architecture, variants, requirements, behaviors (states, functions), traceability, configurations

▶ Simulation

- ▷ Analytical model integration through parametric diagram (Modelica, MATLAB, FMU)
- ▷ Instances to input different configurations and find optimal solution
- ▷ Automatic requirements verification and natural languages analysis

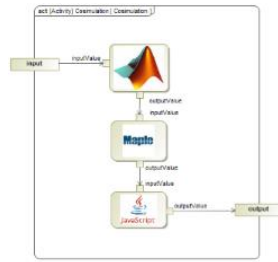
Note: all presented capabilities exist for years and are rock solid

Demo

Missile System Trade-Off Analysis

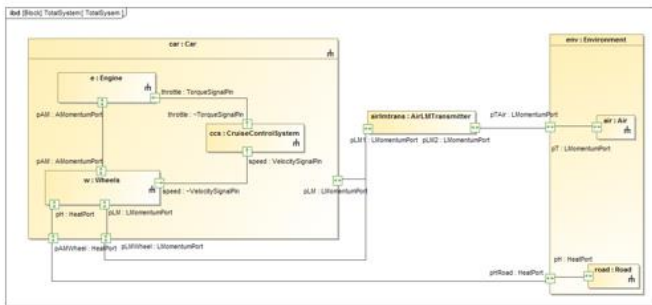
Summary

- ▶ With simulation you can:
 - ▷ Enhance user understanding by executing system model (structure and behavior)
 - ▷ Do engineering analysis by using rollups, trade studies, system testing
 - ▷ Perform V&V – record and execute test cases
 - ▷ Integrate with other analytic tools (Modelica, etc.) and reusable FMU
- ▶ Future
 - ▷ Modelica and Simulink export using OMG SysPhs standard (v19.0 SP2)
 - ▷ FMU generation from SysML for co-simulation
 - ▷ Integration with 3DS Experience platform for continue development, integration, verification, and optimization.



OMG standard for SysML Extension for Physical Interaction and Signal Flow Simulation (SysPhS)

- SysML BDD, IBD, State Machines, Parametric export to Modelica and Simulink.

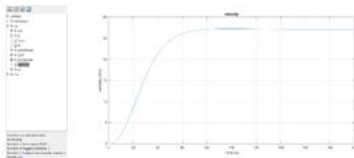
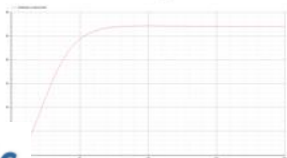
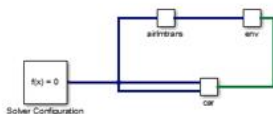


Modelica

Simulink/Simscape

```

1 model TotalSystem
2   Car car(q = 3, slope = slope, w.velocity.start = 0.0,
3     w.velocity.fixed = true, e.torque.start = 0.0, e.torque.fixed =
4     true);
5   parameter Real q(start = 0.0, fixed = true);
6   parameter Real airDensity(start = 1.2, fixed = true);
7   parameter Real slope(start = 0.0, fixed = true);
8   EqvComponent env;
9   AirFlowTransmitter airInTrans(crossSectionalArea = frontArea,
10    airDensity = airDensity);
11   parameter Surface frontArea(start = 20.0, fixed = true);
12   equation
13     connect(car.p2Wheel, car.p2M);
14     connect(env.pRoad, car.p4Wheel);
15     connect(car.p1M, airInTrans.p1M);
16     connect(airInTrans.p2M, env.p1Air);
17   end TotalSystem;
    
```



No Magic

QUESTIONS?

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The Popular and Standards-Compliant Modeling Languages and Frameworks

► **OMG and ISO Standards.**

- ▷ SysML - Standard Language for systems engineering - SysML (OMG and ISO standard). The most popular systems modeling language (large community, academy, industry behind, a lot of papers and cases).
- ▷ Other languages and framework are compatible with SysML: UAF, UML, BPMN.

► **Interchange standards:**

- ▷ ReqIF, FMI, XMI, Modelica / Simulink interchange (SysPhs), OSLC

► **Model simulation and execution standards:**

- ▷ fUML (Executable UML), State Machines (W3C SCXML standard), Actions/scripts (JSR223 standard)



