System Model Simulation - Monte Carlo, Probabilities, and more…

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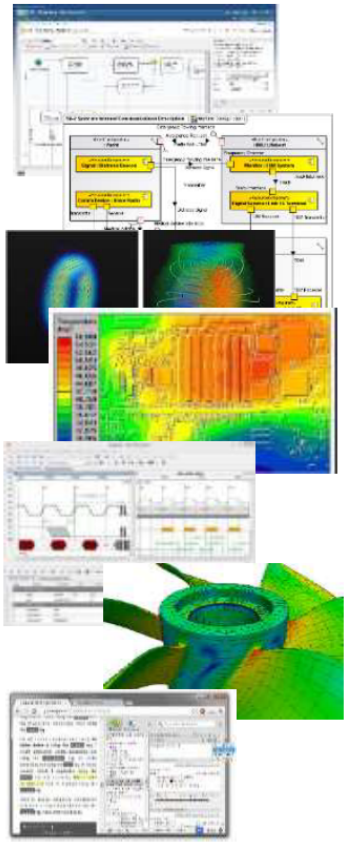
Simulation

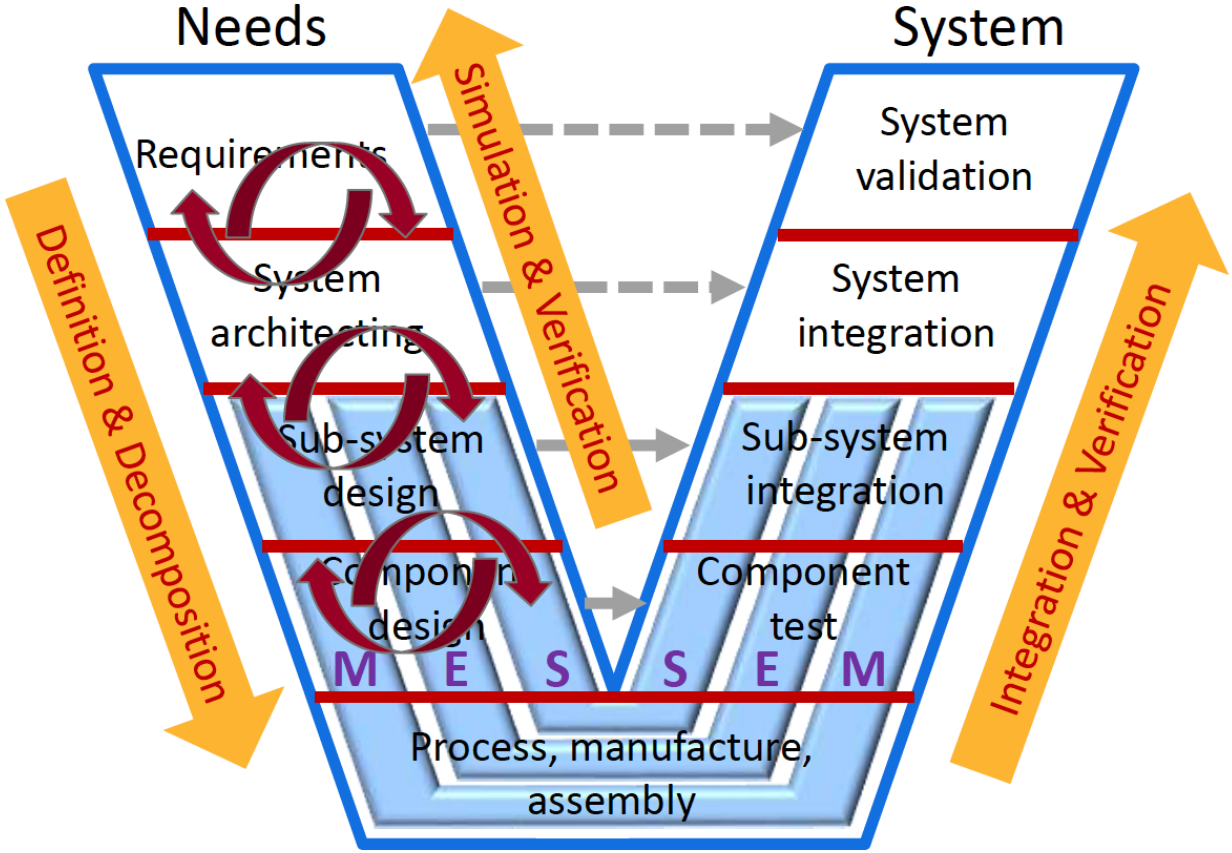
The purpose of a simulation is to gain system understanding without manipulating the real system, either because it is not yet defined or available, or because it cannot be exercised directly due to cost, time, resources or risk constraints.

Simulation is typically performed on a model of the system.

System engineering process (V process)



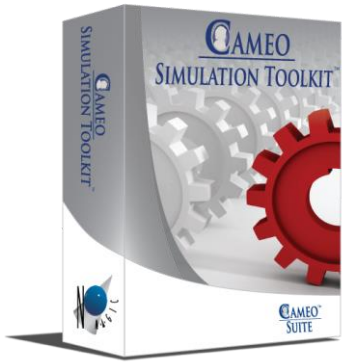
REQ model
SysML model
Simulation
AML/Software
MCAD
ECAD
Timing
Thermal
Stress
etc.



Credits: Pawel Chadzynski & Michael Pfenning - MBSE and the Business of Engineering

Cameo Simulation Toolkit

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



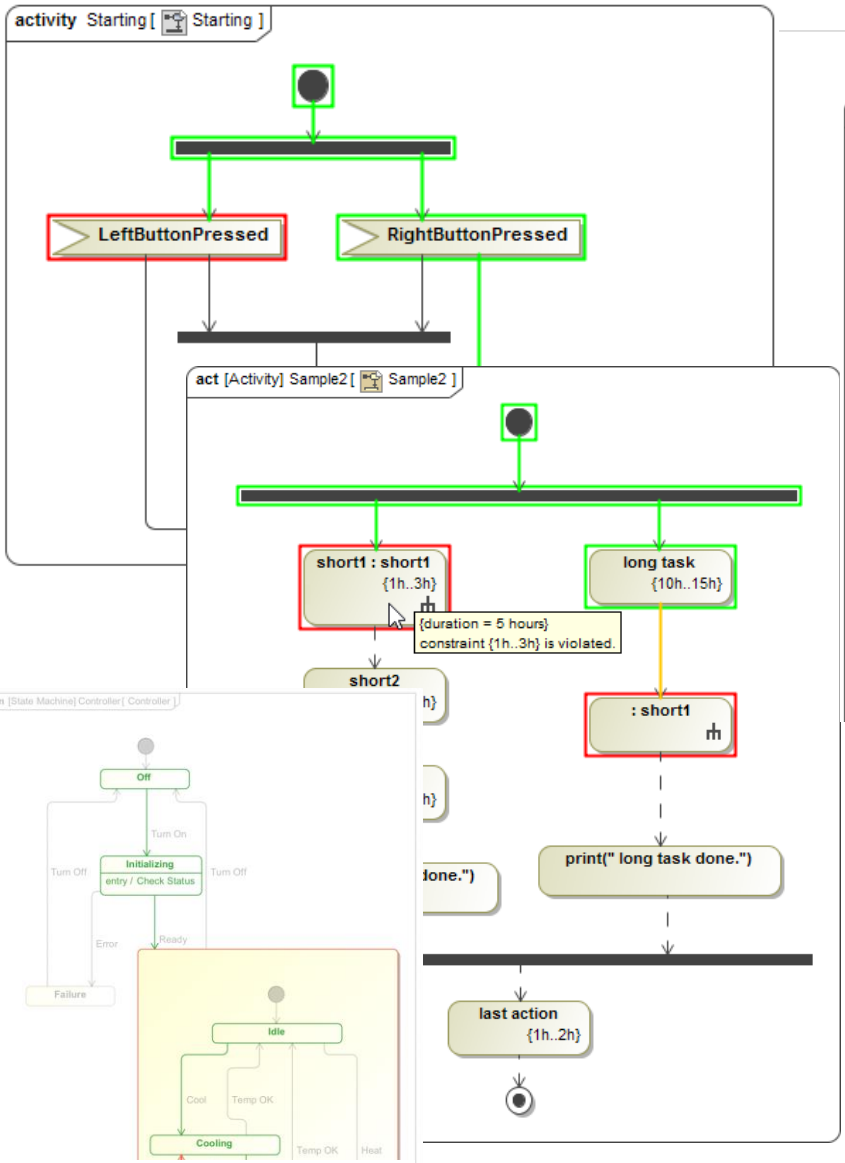
- The standard based model execution of:
  - Activities (OMG fUML standard)
  - Composite structures (OMG PSCS)
  - Statemachines (W3C SCXML and OMG PSSM standards)
  - Actions/scripts (OMG ALF, JSR223 scripting)
  - Parametrics (OMG SysML standard)
  - Sequence diagrams (OMG UML Testing Profile)

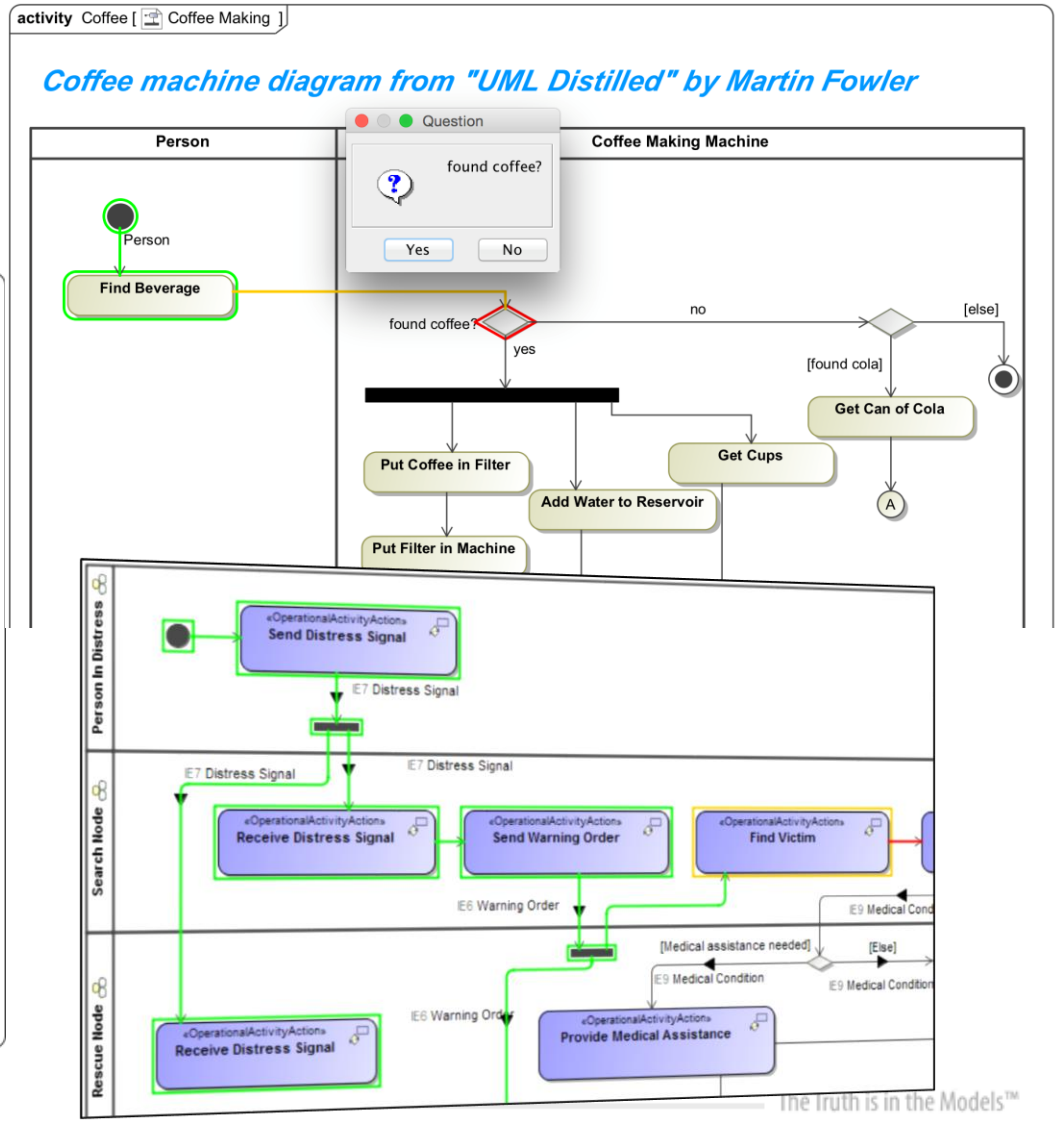
OBJECT MANAGEMENT GROUP

Engineering analysis

- 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

Simulation and Analysis

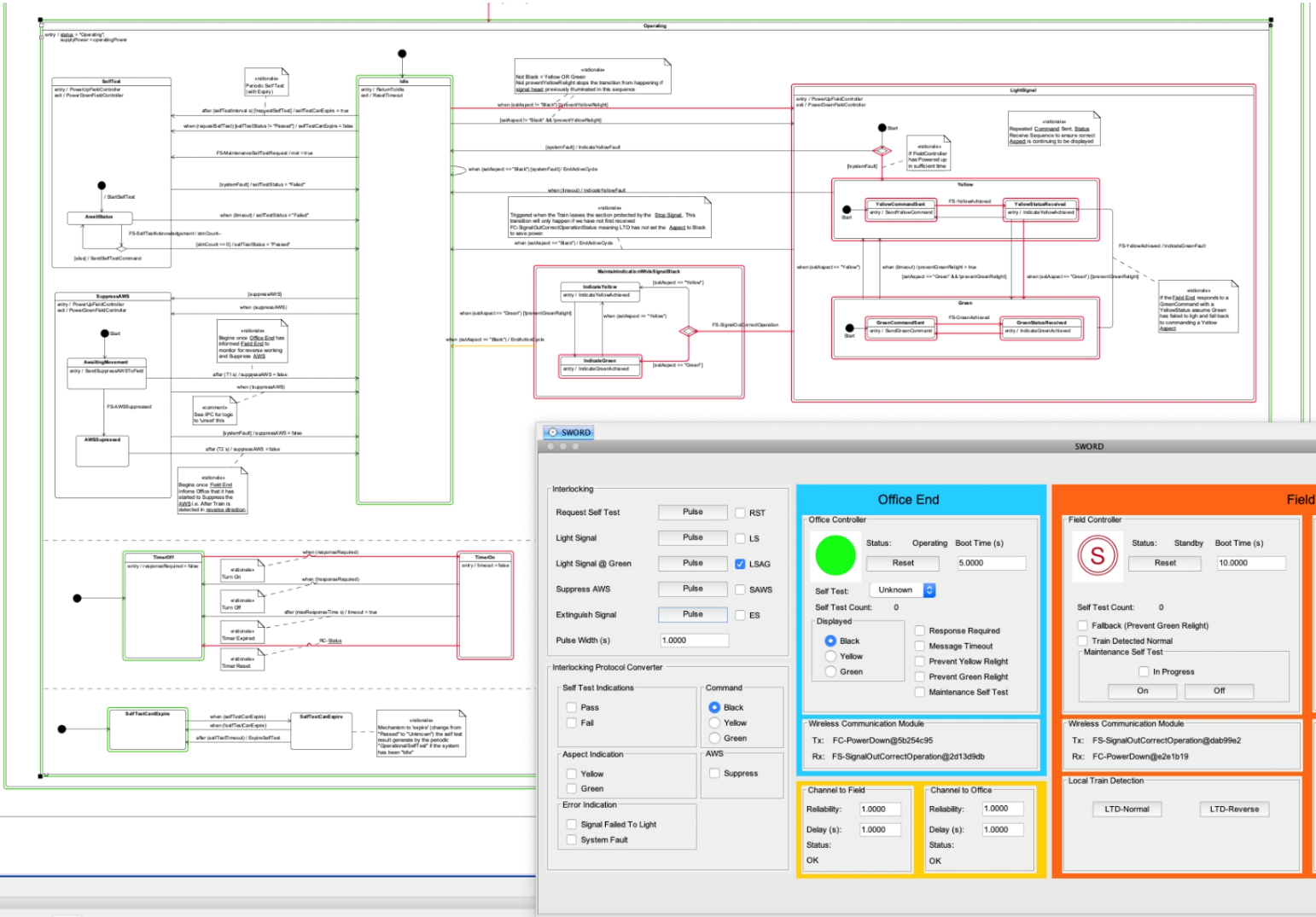




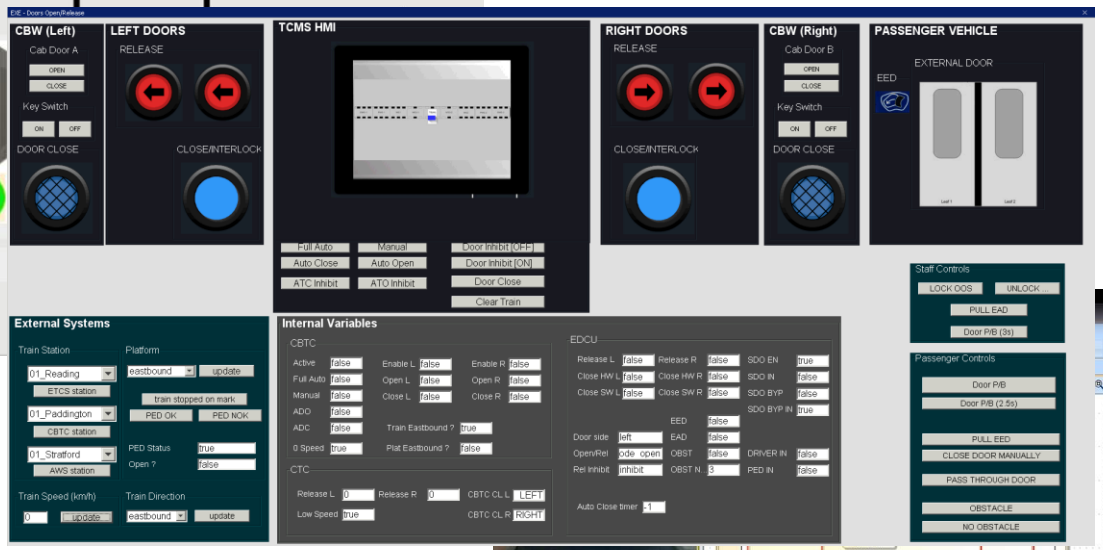
CATIA | No Magic

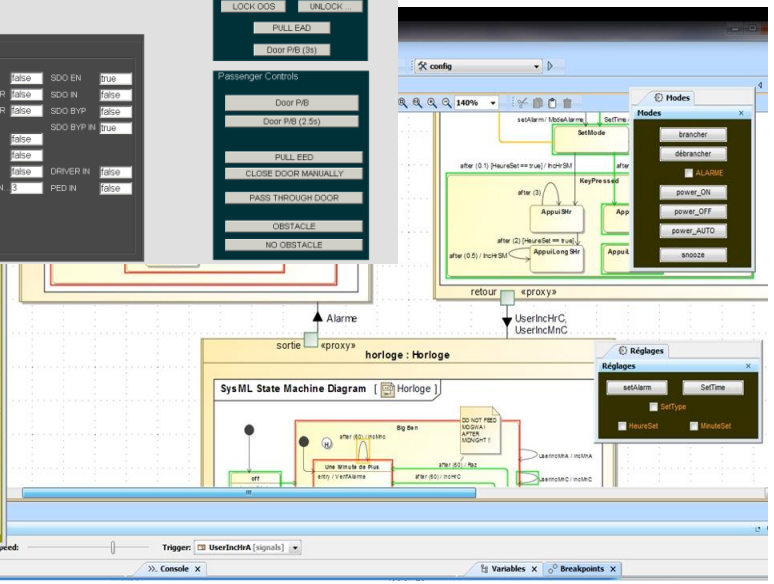
The Truth is in the Models™

User Interface + animation



GUI examples

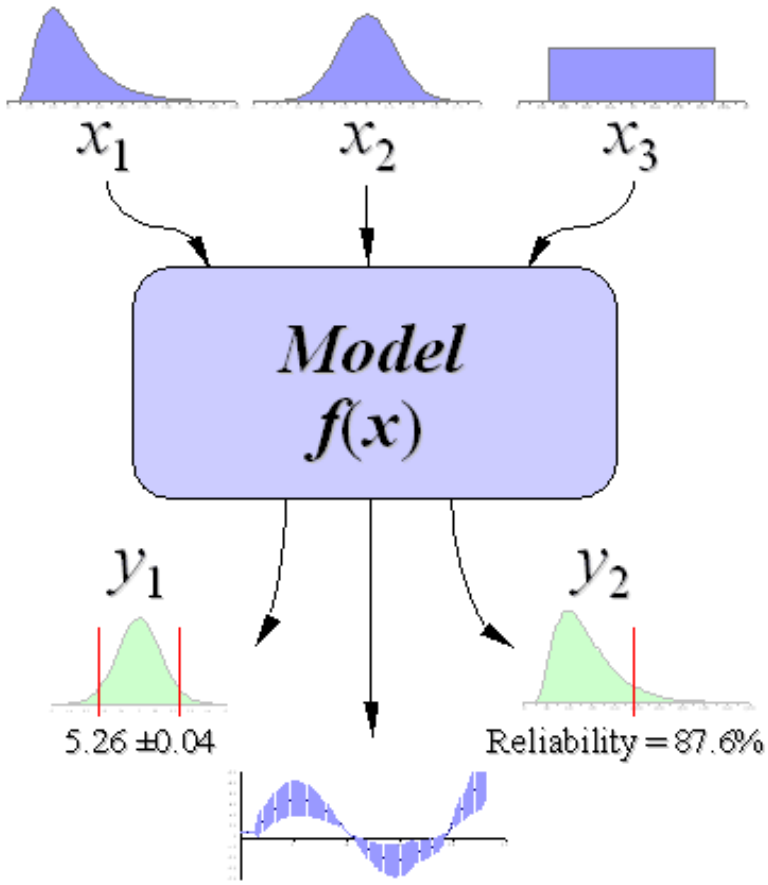




Monte Carlo Analysis

Monte Carlo - Uncertainty Propagation

The Monte Carlo method is a method for analyzing uncertainty propagation, where the goal is to determine how random variation, lack of knowledge, or error affects the sensitivity, performance, or reliability of the system that is being modeled.



Monte Carlo simulation

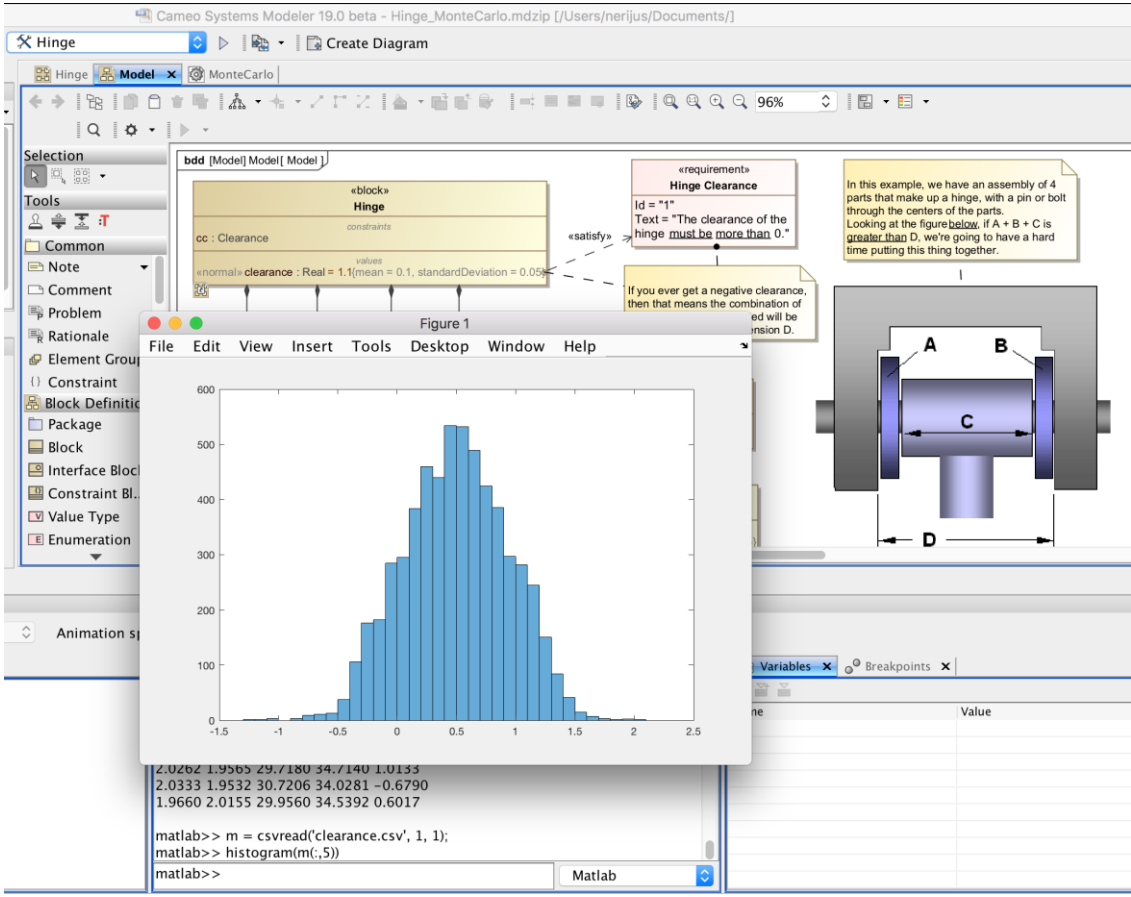
Distributed Property

- Normal distribution
  - Mean +- Standard deviation
- Uniform distribution
  - Min – max

Number of runs

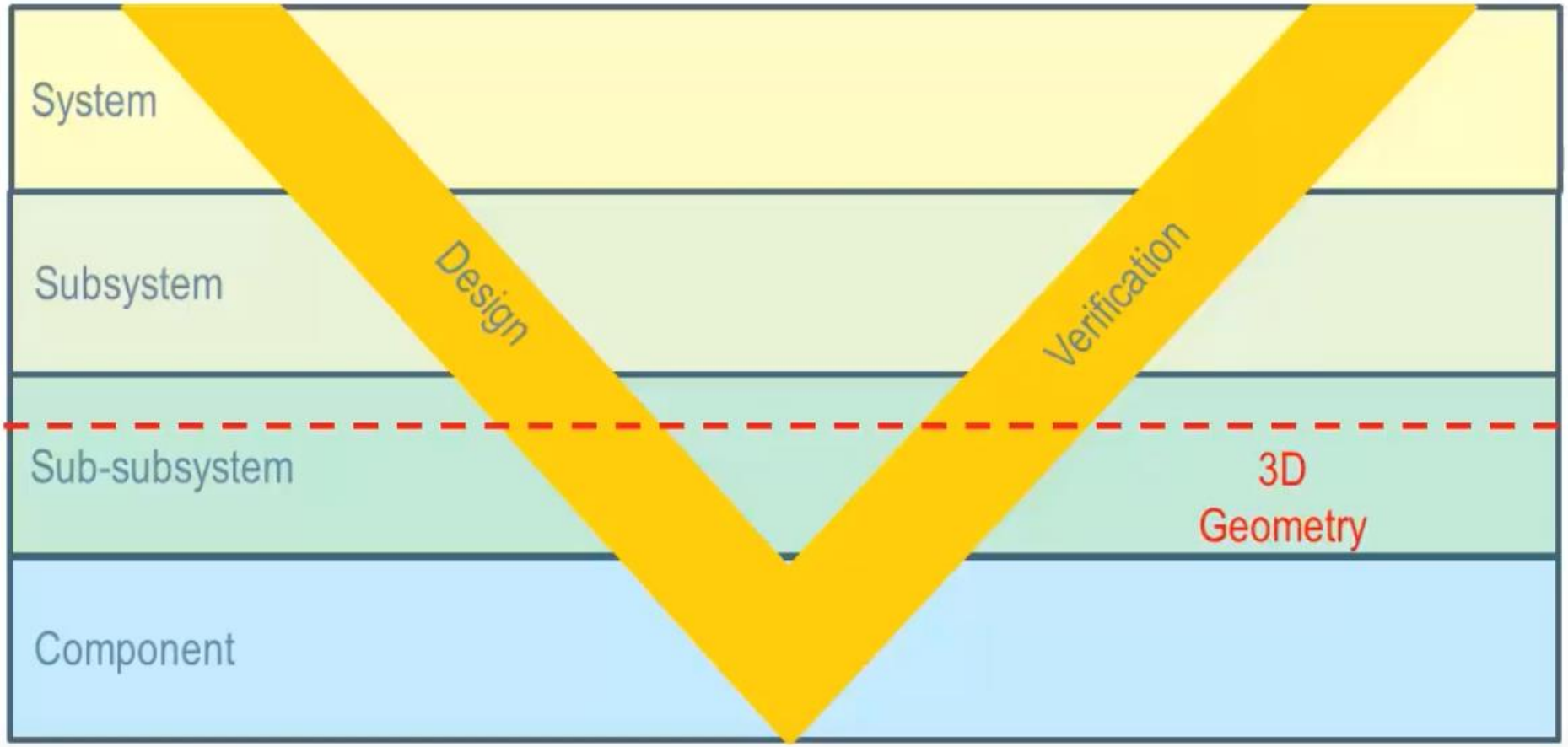
Recording CSV

Histograms



Demo!

Questions?


System
Subsystem
Sub-subsystem
Component
Design
Verification
3D
Geometry

Lumped element model

The **lumped element model** (also called **lumped parameter model**, or **lumped component model**) simplifies the description of the behaviour of spatially distributed physical systems into a topology consisting of discrete entities that approximate the behaviour of the distributed system under certain assumptions. It is useful in electrical systems (including electronics), mechanical multibody systems, heat transfer, acoustics, etc. Mathematically speaking, the simplification reduces the state space of the system to a finite dimension, and the partial differential equations (PDEs) of the continuous (infinite-dimensional) time and space model of the physical system into ordinary differential equations (ODEs) with a finite number of parameters.